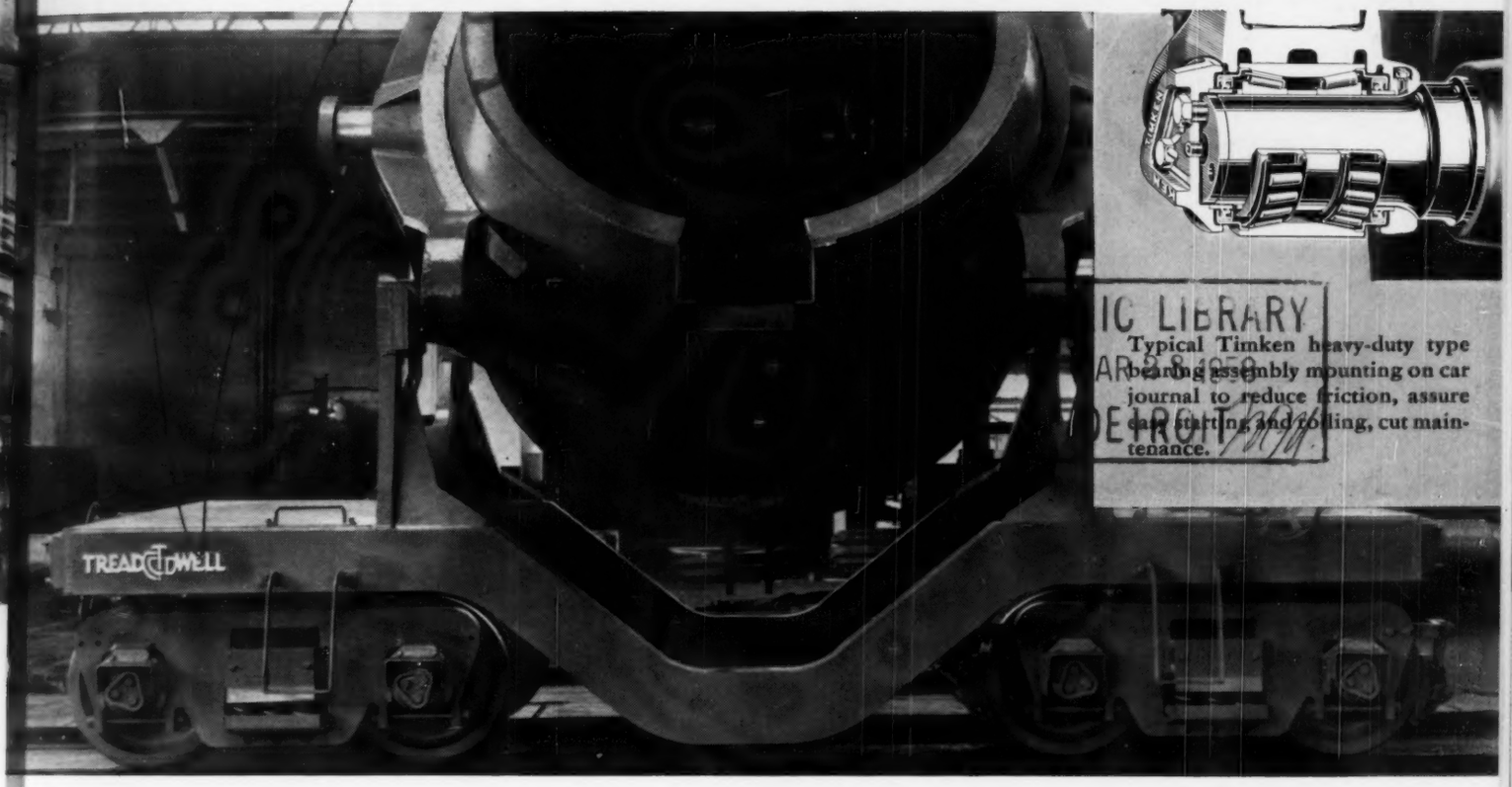
Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

MARCH, 1958

TECHNOLOGY DEPT.

TABLE OF CONTENTS, PAGE 3



IC LIBRARY
AR 3 8 1958
DETROIT

Typical Timken heavy-duty type bearing assembly mounting on car journal to reduce friction, assure easy starting and rolling, cut maintenance.

TIMKEN® bearings cut starting resistance 88% —help 75-ton ladle car roll easier, work longer

THIS 75 gross-ton-load ladle car must start, roll and keep rolling easily, and do it with safety, efficiency and minimum maintenance. Its fabricators, Treadwell Construction Company found a ready answer by mounting eight heavy-duty Timken® AP (All-Purpose) bearing assemblies on the axles.

Because they *roll* the load, Timken tapered roller bearings cut starting resistance up to 88 per cent. There's no metal-to-metal sliding friction. Loaded cars start easier and with less power loss.

Timken bearings carry the tremendous weight, take the heavy shock loads. Their rollers and races are case-carburized, with hard, wear-resistant surfaces over tough, shock-resistant cores. Full line contact between rollers and races provides extra load-carrying capacity. And because they are *tapered*, Timken bearings take *both* radial and thrust loads in any combination, without using costly extra thrust devices. They're geometrically designed and precision made to have true rolling motion, practically eliminate friction. Axle wear is eliminated. Timken bearings give long life with minimum maintenance.

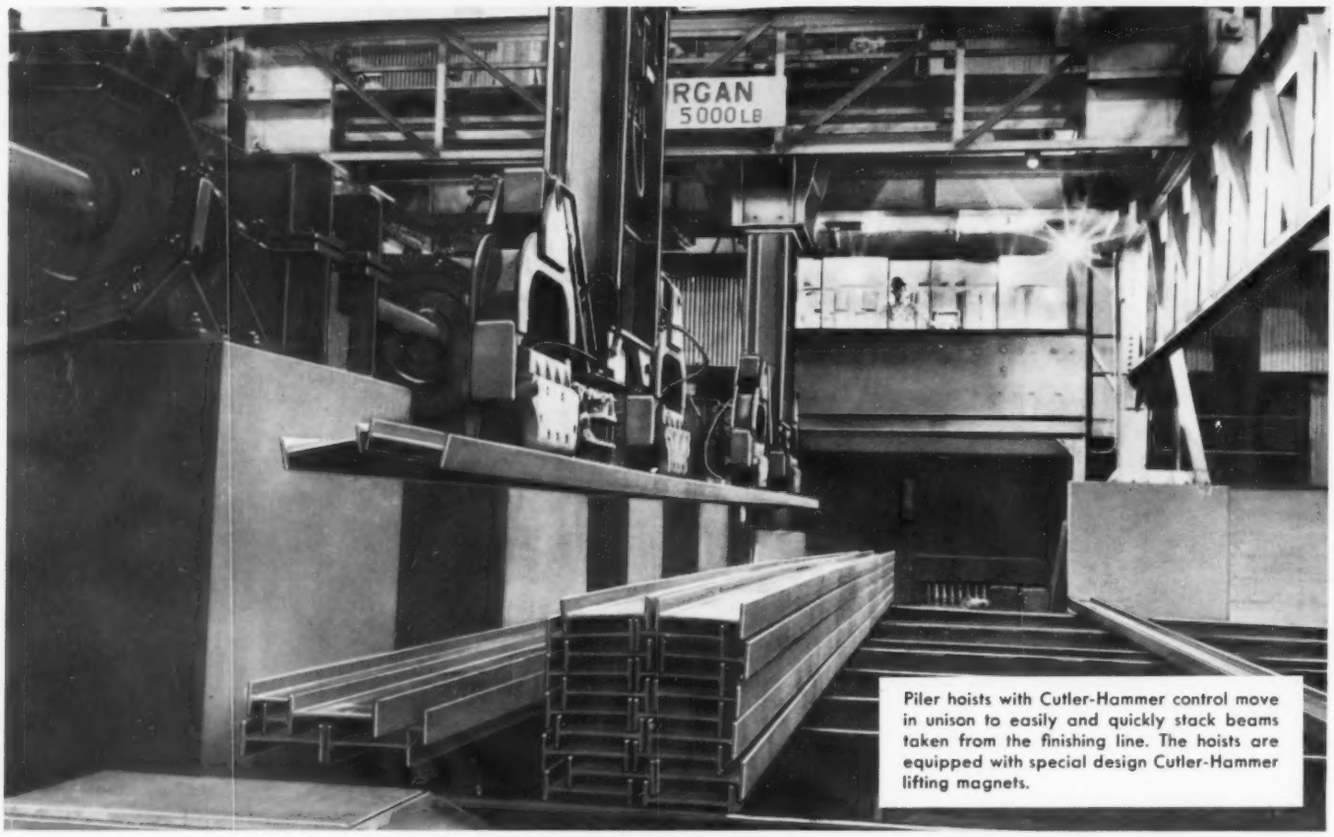
And Timken bearings cut lubricant costs because they're designed with seals to keep dirt and moisture *out*, lubricant *in*.

To get all these advantages, specify Timken bearings for the machines you buy or build. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

TIMKEN TAPERED ROLLER BEARINGS ROLL THE LOAD

TRADE-MARK REG. U. S. PAT. OFF.



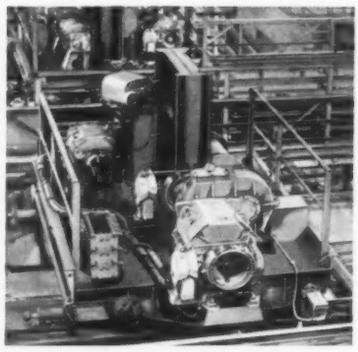
Piler hoists with Cutler-Hammer control move in unison to easily and quickly stack beams taken from the finishing line. The hoists are equipped with special design Cutler-Hammer lifting magnets.

Cutler-Hammer Control and Magnets team to cut beam handling costs

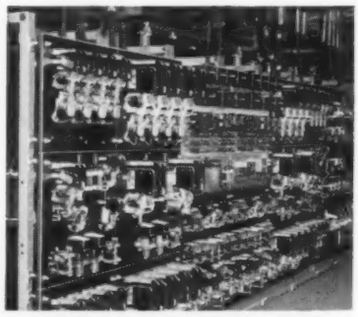
Classifying and stacking finished beams to fill customer orders has always been a production bottleneck involving both back-breaking manual handling and the frequent use of an overhead crane withdrawn from its normal service. But now at U. S. Steel's South Works, the job is done quickly and safely by special beam piling cranes equipped with Cutler-Hammer D-c magnetic crane control and special Cutler-Hammer bi-polar lifting magnets. The heart of this beam handling system is the unique controller which automatically positions the hoist trolleys accurately on adjacent piler crane bridges. With this modern electrical equipment, which includes a Cutler-Hammer designed magnetic amplifier type position regulator, the piler hoist operator simply and easily selects beams as specified from the end of the finishing line and stacks them according to the orders in hand.

This is another typical example of mill engineers and Cutler-Hammer engineers working together to solve mill problems. Another instance among many at the great USS South Works where Cutler-Hammer equipment serves faithfully from the giant ore unloaders at the start of mill operations to the unique piler hoists at the very end of the finishing line. You too will find it pays to work with Cutler-Hammer to gain new efficiency and new savings with time-honored Cutler-Hammer dependability.

CUTLER-HAMMER Inc. 1269 St. Paul Avenue, Milwaukee 1, Wisconsin.
Associate: Canadian Cutler-Hammer, Ltd., Toronto.



Overhead view of beam piling hoists showing Cutler-Hammer brakes and limit switches used.



Cutler-Hammer control panel for unique piler hoists at USS South Works.

CUTLER-HAMMER
MOTOR CONTROL
C-H

LOOK TO CUTLER-HAMMER MILL EXPERIENCE . . . AS BROAD AS IT IS LONG

IRON AND STEEL ENGINEER; is published monthly by Association of Iron and Steel Engineers at 20th and Northampton Sts., Easton, Pa. Editorial and advertising offices, 1010 Empire Bldg., Pittsburgh 22, Pa. Second-class mail privileges authorized at Easton, Pa.

modernization...
AT MODERATE COST

In the modernizing, revamping, or up-dating of production facilities—several approaches are available. Components can be changed. Alterations can be made. New ideas can be adapted to existing equipment. New units can be added.

The proper choice can make a difference in production yield and the expenditure. The choice requires good thinking and proper application of ideas . by people who know their business.

We are working with many companies right now on idea modernization for butt weld, seamless, stretch reducing, continuous galvanizing, continuous annealing, electrolytic tinning, stainless processing, silicon processing, cold drawing, rubber, plastic and chemical.

A discussion of your ideas and plans may show how you can modernize at moderate cost.

AETNA•STANDARD
THE AETNA-STANDARD ENGINEERING COMPANY

General Offices: Pittsburgh, Pa. • Plants: Ellwood City, Pa., Warren, Ohio
Research Laboratory: Akron, Ohio

CONTINUOUS GALVANIZING LINES • CONTINUOUS ANNEALING LINES • CONTINUOUS ELECTROLYTIC TINNING LINES • SIDE TRIMMING AND SHEAR LINES AND OTHER FINISHING EQUIPMENT • CONTINUOUS BUTT WELD PIPE MILLS • SEAMLESS TUBE MILLS • DRAWBENCHES AND OTHER COLD DRAW EQUIPMENT • ROLLS AND CASTINGS • EXTRUDERS, MILLS, PRESSES FOR RUBBER AND PLASTIC

This sort of "school room"
keeps Wean Engineers at the top
of their class. It's typical of...

WEAN CREATIVE ENGINEERING

The "students" are Wean Engineers—

The instructor, D. W. Plumer—a General Electric Company Application Engineer. The occasion: G-E's Application Engineering Course being presented outside the G-E organization for the first time.

Wean feels honored to participate in this important industrial "first". It is in line with an established policy of research and development which gives added meaning to the phrase . . . "Wean Creative Engineering."

THE WEAN ENGINEERING COMPANY, INC., WARREN, OHIO

611

T. J. ESS, *Editor*
I. E. MADSEN, *Associate Editor*
W. C. FRIESEL, *Advertising Manager*
T. A. KOCIS, *Production Manager*

Board of Directors

PRESIDENT
LEONARD LARSON
Chief Engineer
Cleveland Works, Republic Steel Corp.

FIRST VICE PRESIDENT, EMIL KERN, *Vice President of Engineering*, Allegheny Ludlum Steel Corp.

SECOND VICE PRESIDENT, S. C. READ, *Director, Construction and Maintenance*, Jones & Laughlin Steel Corp.

TREASURER, C. E. PRITCHARD, *Superintendent of Mills*, Alan Wood Steel Co.

SECRETARY, H. L. JENTER, *Vice President-Operations*, American Steel and Wire Div., United States Steel Corp.

PAST PRESIDENTS: W. H. COLLISON, *Plant Superintendent*, Blast Furnaces and Coke Plant, Great Lakes Steel Corp.

J. D. O'ROARK, *Assistant Manager*, Department of Service and Maintenance, Electric, Weirton Steel Co.

DIRECTOR-AT-LARGE: C. W. BRUCE, *Chie Engineer*, Steel Plants, Republic Steel Corp.

DIRECTORS: F. B. BEVELHEIMER, *Power & Fuel Engineer*, Jones & Laughlin Steel Corp.

E. C. THOMAS, *Works Manager*, Pacific States Steel Corp.

J. R. POWELL, *Cleveland Works Manager*, Jones & Laughlin Steel Corp.

A. M. CAMERON, *Superintendent*, Blooming & Bar Mills, Atlas Steels, Limited.

C. A. BAILEY, *Lubrication Engineer*, National Tube Div., United States Steel Corp.

H. R. KNUST, *Assistant General Manager*, Sparrows Point, Bethlehem Steel Co.

A. KRAUSE, *Manager*, Rolling Mill Plant, Steel Div., Ford Motor Co.

W. T. PURVANCE, *Geneva Works Engineer*, Columbia-Geneva Steel Div., United States Steel Corp.

W. D. REES, *Superintendent*, Bar & Blooming Mill, Sharon Steel Corp.

J. E. BODOH, *General Supervisor-Electrical*, Gary Steel Works, United States Steel Corp.

S. O. EVANS, *Manager of Tubing Operations*, The Babcock & Wilcox Co.

F. H. WICKLINE, *Assistant Chief Engineer*, National Tube Div., United States Steel Corp.

GEORGE H. SCHAEFFER, JR., *Superintendent of Electrical Dept.*, The Carpenter Steel Co.

P. W. PHENEGER, *Administrative Vice President*, The Pollak Steel Co.

R. J. TREMBLAY, *General Manager*, Los Angeles Bethlehem Pacific Coast Steel Corp.

A. S. MERROW, JR., *Assistant Fuel Engineer*, Bethlehem Steel Co.

A. W. SCHLECHTE, *Chief Electrical Engineer*, Granite City Steel Co.

H. B. BUCKINGHAM, *Electrical Engineer*, Tennessee Coal and Iron Div., United States Steel Corp.

Managing Director
T. J. ESS
Empire Building, Pittsburgh, Pa.

Iron AND Steel ENGINEER

Volume XXXV · Number III **MARCH 1958**

71 Turn-Up and Turn-Down in Hot Rolling
by G. E. Kennedy and F. Slamar

80 AISE District Chairmen—1957–1958

82 Automatic Contour Turning of Large Mill Rolls
by William Hyams

90 Trends in Steel Mill Power Plants
by Howard G. Kitt and Robert W. Worley

98 Electric Furnace Steel Manufacturing
by W. E. Lewis

103 Program—AISE Spring Conference

105 Abstracts of Technical Papers to be Presented at AISE Spring Conference

112 The Dollars and Sense of Pickle-Liquor Treatment
by James S. Joseph and E. T. Culver

123 Electrical Drive System For a High Speed Combination Rod Mill
by A. F. Kenyon and H. J. Oakes

137 Current AISE District Section Meeting Notices

Symposium on C. F. & I.'s Pueblo Plant—

138 Production of Seamless Casing and Tubing
by Melvin Sumrall

139 Installation of Stretch Reducing Mill
by Howard L. Mitchell

141 Double Cooling Bed for Rod Mill
by D. H. Driscoll and Clair Renberg

144 Development of Automatic Thickness Controls for Strip Mills
by I. G. Orellana

151 Choosing the Right Fastener
by William P. Acres

154 Trolley Conveyor Handles Rod at Atlantic Steel

157 New Wrought Iron Developed by A. M. Byers Co.

159 Good Engineering Gives Good Piping Layouts

164 Pittsburgh Coke & Chemical Co. Starts Ferromanganese Production

171 Convertible Rolling Mill Compacts Powders Into Sheet and Strip

174 J & L Installs Sintering Plant At Otis Works

176 Wallingford Steel Company Adds New Mill Equipment

181 Model Studies Expect to Improve Steel Plant Precipitator Operation

DEPARTMENTS

11 Crops and Shorts
21 Patent Reviews
189 Date-line Diary
197 Industry News
203 Publication Service
211 Personnel News
223 Equipment News
238 Book Reviews
239 Index to Advertisers

Published Monthly by

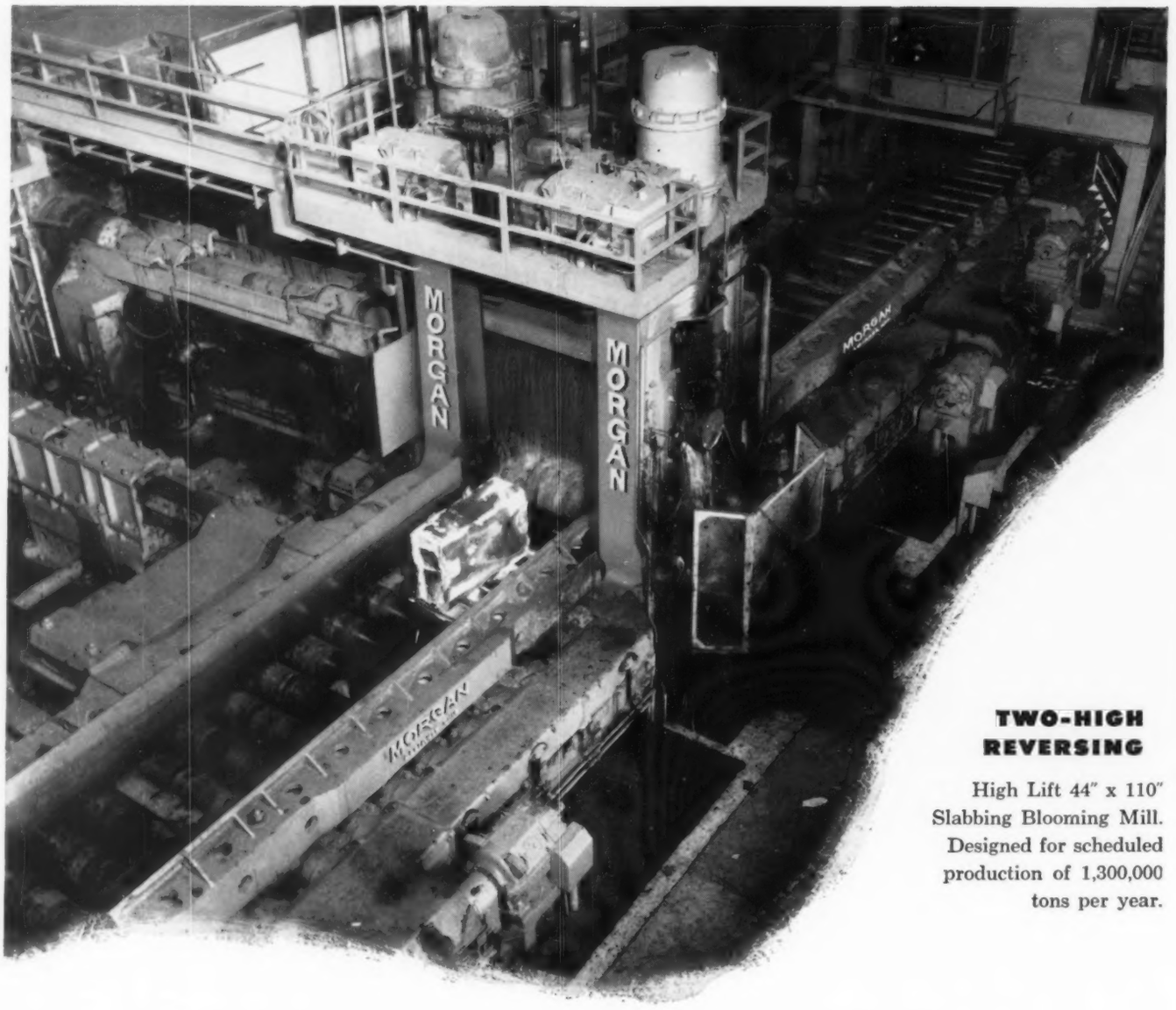
ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING PITTSBURGH 22, PENNSYLVANIA

Statements and opinions given in articles and papers appearing in "Iron and Steel Engineer" are the expressions of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility.

Copyright, 1958, The Association of Iron and Steel Engineers.

Indexed by Engineering Index and by Industrial Arts Index.

Single Copy Foreign Prepaid $2.00 (U. S. funds) Single Copy $1.50
Subscription price in U. S. and Canada (U. S. funds).....$ 7.50 per year
Subscription price in foreign countries (U. S. funds).....$10.00 per year



TWO-HIGH REVERSING

High Lift 44" x 110" Slabbing Blooming Mill. Designed for scheduled production of 1,300,000 tons per year.

HOW WOULD YOU WEIGH A ROLLING MILL?

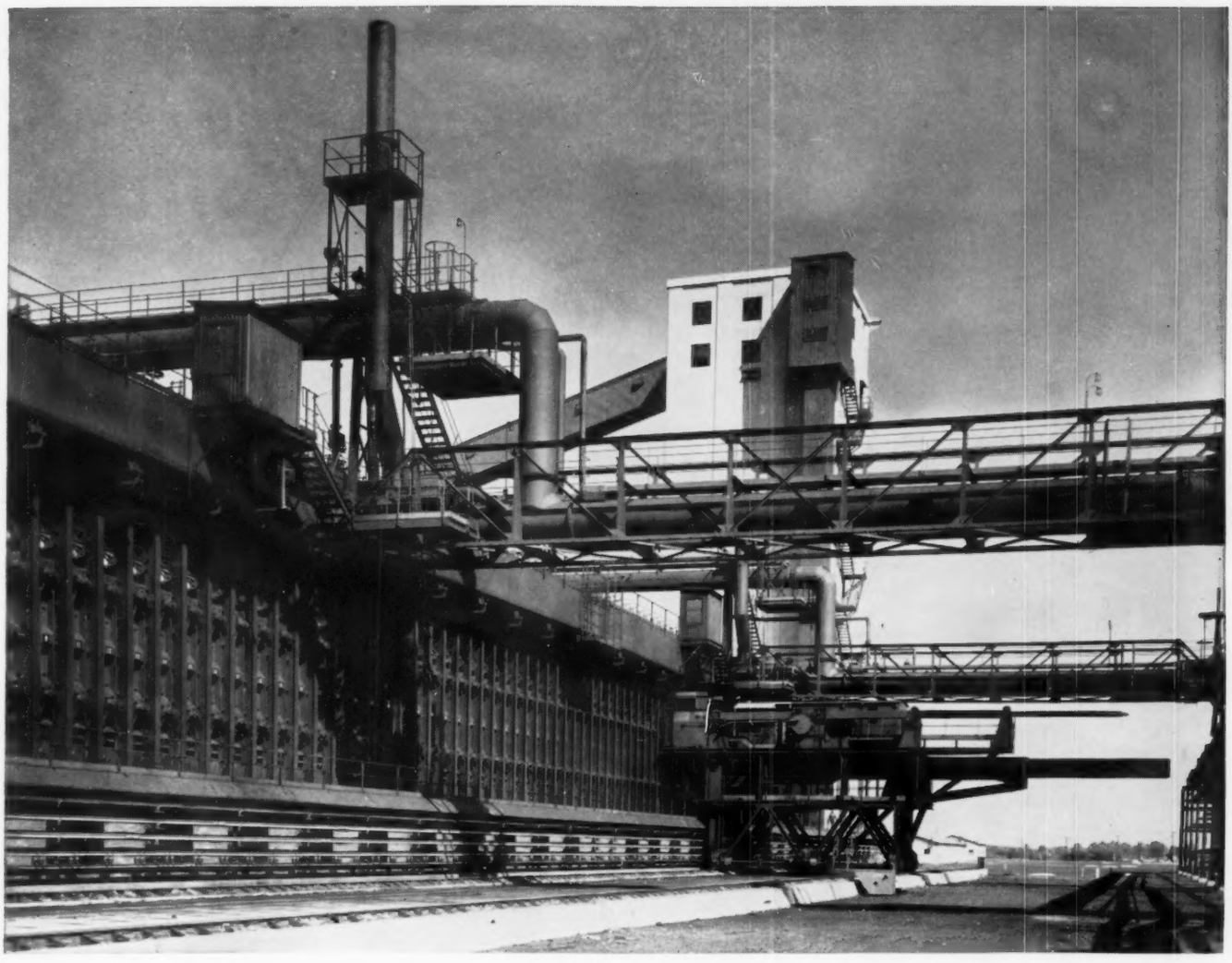
Efficient, profitable operations in a steel mill depend in large measure on continuous-flow production. Bonus capacity and *unquestionable dependability* tip the scale in favor of slabbing and blooming mills designed and built by The Morgan Engineering Company.

You weigh the cost of "the big stuff" in terms of uninterrupted production. Every part of a giant rolling mill must be engineered for *assured* performance . . . built to face up to the toughest jobs the industry will ask of it.

The Morgan Engineering Company has been known for advanced design and trusted craftsmanship for ninety years. Close contact with the ever-increasing needs of metal producers has resulted in greater speed, capacity and efficiency; lower operating and maintenance costs wherever you see the nameplate MORGAN . . . Alliance, Ohio.

THE MORGAN ENGINEERING CO. *Alliance, Ohio*

Overhead electric traveling cranes, gantry cranes, open hearth special cranes, plate mills, blooming mills, structural mills, shears, saws and auxiliary equipment.



Giant pusher for 76 coke ovens is CLARK CONTROLLED

Coke is discharged from this battery of 76 ovens—almost 300 feet long—at the rate of 58 tons per hour. The enormous Clark-controlled pusher moves from oven to oven on a regular schedule, emptying each as it becomes ready . . . Designed and built by the Wilputte Coke Oven Division of Allied Chemical and Dye Corporation of New York, the 300,000 pound pusher depends on Clark apparatus for its precise, dependable operation. The six separate motors, totalling 175 HP, are controlled by a Clark Bulletin 9300 Coke Pusher Control. The special Clark Control Panel is shown at the left.

The **CLARK** **CONTROLLER** *Company*

Everything Under Control 1146 East 152nd Street • • Cleveland 10, Ohio

IN CANADA: CANADIAN CONTROLLERS, LIMITED • MAIN OFFICES AND PLANT, TORONTO

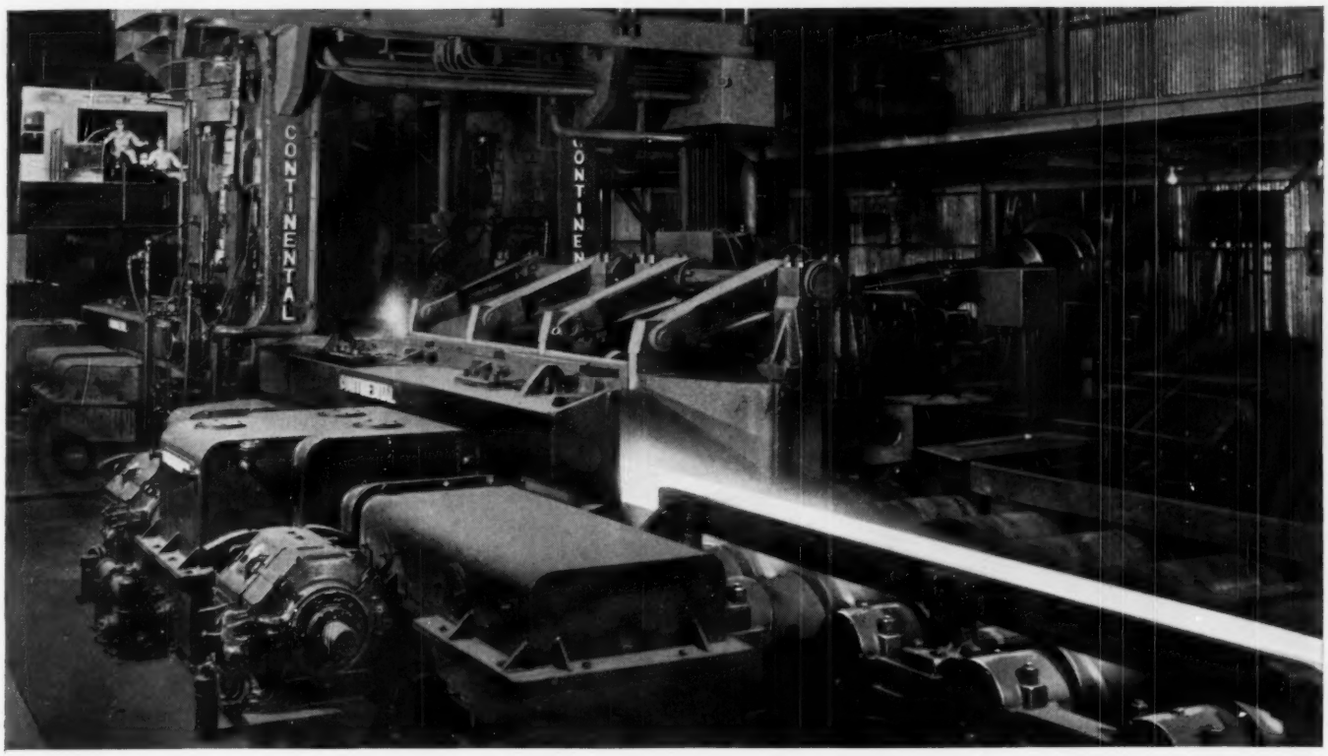
VICTOR R. BROWNING
MILL TYPE CRANES

to Specification..

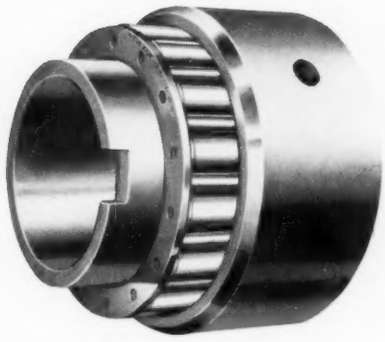
Basically designed as required by A.I.S.E. specifications, mill type cranes built by Victor R. Browning & Co., Inc. also offer the opportunity of specifying preferences and standards prevailing in the purchaser's plant. May we have your next inquiry?

VICTOR R. BROWNING & COMPANY, Inc.
WILLOUGHBY (CLEVELAND), OHIO
DESIGNERS AND BUILDERS OF ELECTRIC OVERHEAD TRAVELING CRANES AND HOISTS AND ELECTRIC REVOLVING CRANES

How HYATT bearing advantages help produce more steel at lower cost:



ON TABLE ROLLS—SEPARABLE HYATTS GREATLY FACILITATE ROLL REPLACEMENT!



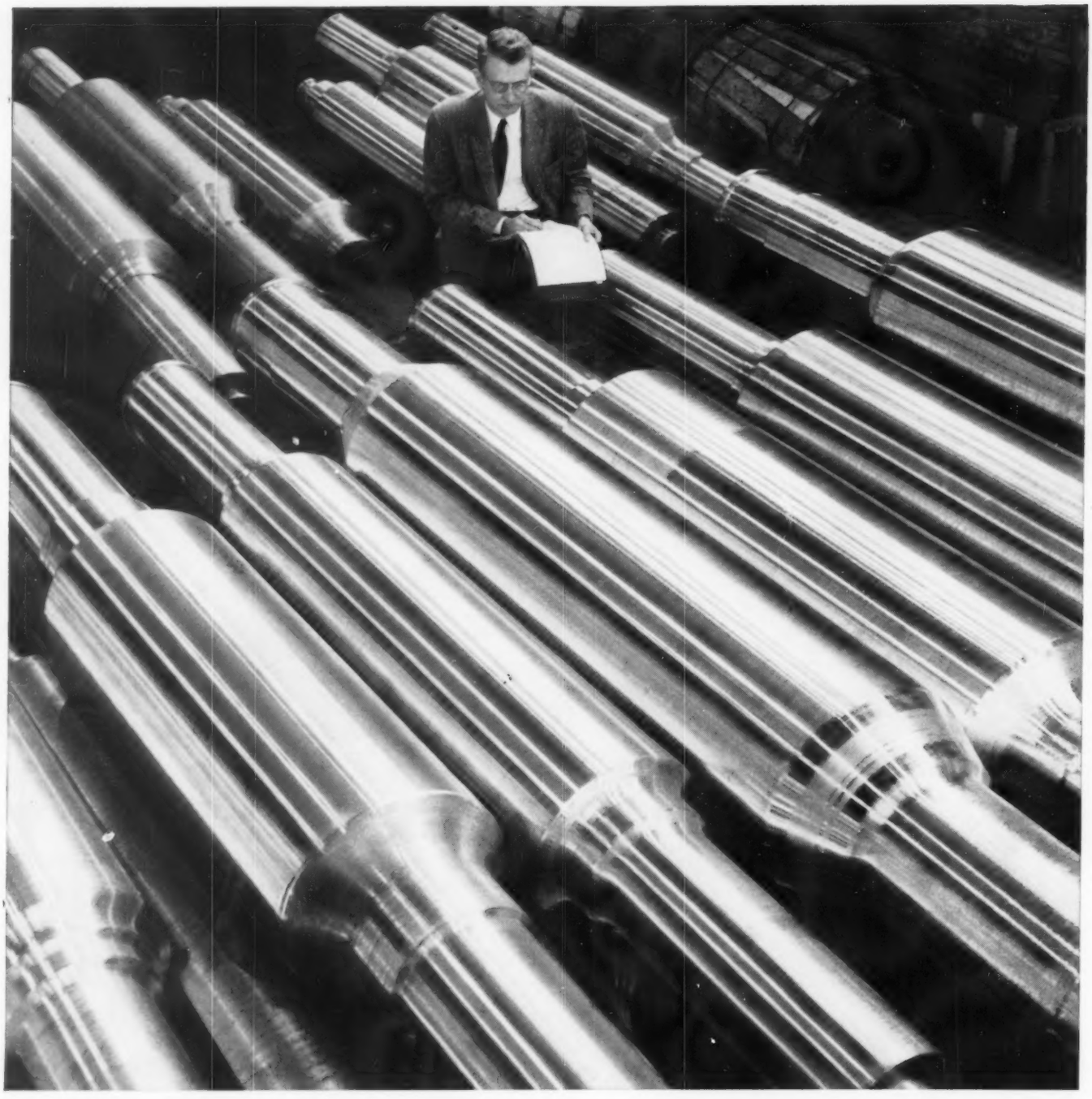
When table rolls must be removed for repair, separable-race HYATT Hy-Rolls cut costly downtime to the minimum because they can be disassembled and reassembled so rapidly. Their straight cylindrical design not only provides maximum load-carrying capacity and resistance to shock loads, but permits roll expansion under high heat. Service-proved advantages like these have made HYATT Hy-Rolls first choice of the steel industry for decades—and constantly-improved quality makes HYATTS more than ever your best buy today! Hyatt Bearings Division, General Motors Corporation, Harrison, N.J.; Pittsburgh; Detroit; Chicago; Oakland, Calif.

STANDARDIZE ON HYATTS FOR:
MAIN TABLES • RUNOUT TABLES • FURNACE TABLES
FEED ROLLERS • AUXILIARY ROLLERS • LINESHAFTING
MILL MOTORS • CRANES • CHARGING AND INGOT CARS

THE RECOGNIZED LEADER IN CYLINDRICAL BEARINGS

1908–1958 GM FORWARD FROM FIFTY

HYATT HY-ROLL BEARINGS FOR STEEL INDUSTRY



Forged hardened rolls to your exact specifications

Things are always busy in the shop where Bethlehem forged rolls are inspected and readied for shipment.

On any given day you're apt to see dozens of gleaming new rolls waiting side by side for their final okay. Often they're of assorted sizes and shapes, with no two alike. Near a 20-ton giant you may spot a midget weighing less than a hundred pounds. Some are long and lean with streamlined contours, and others are short, thick, and stubby.

No matter what your requirements in forged hardened rolls, Bethlehem can fill them. When you place an order with us, you can do so with complete confidence; your specifications on size, shape, hardness, and finish will be met in full. Moreover, you can count on good deliveries. Call us whenever you need rolls for cold-rolling ferrous sheets and strip . . . running-down and finishing operations on copper and brass sheets . . . hot- and cold-rolling aluminum sheets . . . cold-rolling aluminum foil.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

Square D Vertical Action Magnetic Starters Sizes 0, 1, 2, 3, 4 and 5

ONLY SQUARE D GIVES YOU ALL 5

1 *QUICK* INSTALLATION!

No groping or fumbling. Square D gives you lots of wiring space, plenty of knockouts, handy and clearly marked pressure wire connectors.

2 *TOP* PERFORMANCE!

No needless downtime from coil burnout, mechanical binding, contact freezing. Square D gives you an extra-capacity magnet with a tough and cool-operating encapsulated coil to handle additional poles and interlocks—a guided single moving part—big silver cadmium-oxide contacts with strong finger springs—arcing yokes on larger sizes.

3 *REAL* OVERLOAD PROTECTION!

No change in trip characteristics because of mismatched parts supplied separately for field assembly, no distortion of heater in installation. Square D gives you melting alloy unit construction—factory-assembled and individually tested for bull's-eye accuracy. Also bi-metal and magnetic designs for automatic reset or adjustable trip applications.

4 *EASY* INSPECTION and MAINTENANCE!

No starter is "maintenance-free." But Square D makes the job easy. Inspection is a breeze. You don't have to remove wiring for contact replacement or take the starter out of the enclosure to change coils.

5 *WIDE-RANGE* ADAPTABILITY!

No need for excessive inventories to avoid costly waiting for non-standard arrangements. Square D provides "off-the-shelf" kits for changing contacts and coils, adding pushbuttons, selector switches, and up to 4 double-throw auxiliary circuits.

Send for the COMPLETE Story!

Square D Company, Dept. 18,
4041 North Richards Street, Milwaukee 12, Wisconsin

Please send me your new bulletin with detailed proof that Square D offers me my best starter investment.

Name_____

Company_____

Address_____

City_____ Zone____ State_____

SQUARE D COMPANY

Cleveland Cranes
FOR
STEEL MILL SERVICE
CLEVELAND CRANES
Modern All-Welded Steel Mill Cranes
5031 EAST 289th ST.
WICKLIFFE, OHIO

Crops *and* Shorts

△ In spite of the fall-off in business, the 1958 Western Meeting of AISE set a new registration record at 522, some 30 higher than ever before. The Statler Hotel at Los Angeles did their usual fine job of handling the various meeting functions. Interest in the technical sessions was evident. More than 350 attended the dinner.

The Utah contingent are already planning for the 1959 Western Meeting in Salt Lake City, and promise that it will be a real one. Also of interest is the report that the Pueblo boys have formed a temporary organization to plan some local activities in their district, with the intent of becoming another official district section of AISE.

△ Anyone can plant corn and have corn come up, but it takes a real expert to plant buckeyes and raise blue grass. Your experts in this editorial office managed it easily, however, in an item in the January issue of Iron and Steel Engineer, when Jones & Laughlin's new stainless steel facilities were transplanted from Louisville, Ohio, to Louisville, Kentucky. They belong of course, in Ohio, and we hope this correction will mollify our Buckeye friends.

△ The 1957 profits of steel companies present some interesting contrasts. Some company earnings were up as much as 18 or 20 per cent above 1956—several (U. S. Steel, Bethlehem, Inland) set all-time records. Other companies dropped with some of the smaller organizations falling as much as 50 per cent under 1956.

In general, the larger companies fared better than the small ones. Of the eight largest, three improved over 1956, two just about held their own and three decreased. The effect of product mix is evident, in that the last three companies are relatively light in pipe, plate and structural products—items which held up better throughout the year.

The final quarter of the year, of course, did most of the damage, although some companies started to sag before that.

△ One of our realistic friends says an ever-loving wife is one who is affectionate only when she wants money.

△ Dr. Kenneth McFarland, addressing the annual dinner of the Engineers Society of Western Pennsylvania, pointed out that almost 60 per cent of the present working force have entered it since 1929. They have not experienced normal times, when the law of supply and demand controls economic conditions. We cannot assume that these individuals know the economic facts of life. A whole generation has grown up in the heady atmosphere of more pay for less work. A whole generation doesn't realize that the customer is the real boss. We must teach them.

Likening the economy to a ship, Dr. McFarland emphasized that you can't scuttle the officers' quarters—or the crew's quarters—and keep the remainder of the ship afloat.

△ The farmer, sacred cow of the politicians, is about to get more manna from Washington. He can get $20 or $25 an acre per year (approximately his estimated profit) for the next five years for not cultivating his farm.

Right now, the steel industry has a few extra open hearths. We estimate that about $1,500,000 per year per furnace would be about right.

△ The American Iron and Steel Institute estimates steel companies plan to spend about $1,000,000,000 during 1958 for additions to and replacement of facilities. This is considerably less than the $1,750,000,000 spent in 1957, but it is equal to the average of the last eight years.

△ Proving that every cloud still has a silver lining, some reports indicate that the current recession has reduced absenteeism, tardiness and gold-bricking among workers, and has resulted in better work. There seems to be less complaining in general, but seniority disputes stemming from lay-offs have actually increased the number of grievances.

△ The steel industry payroll for 1957 was a record $4,001,000,000, according to the American Iron and Steel Institute. Total employment was estimated at 656,700. Wage earners worked an average of 37.2 hours per week. The average hourly payroll cost for wage earners for the year was $2.917, not including almost 30 cents per hour for fringe benefits. The current hourly payroll cost is slightly over $3.

△ A statistician tells us that government civilian employment is increasing about two-and-one-half times as fast as the nongovernment labor force. If this continues, we'll all be working for the government in 2069.

△ World Steel production in 1957 is estimated at a record 322,000,000 net tons—243,000,000 tons from Free World countries, 79,000,000 tons from Iron Curtain countries.

△ The Value Line Investment Survey now estimates 1958 U. S. steel production at 95,000,000 tons. It feels that we have reached bottom on the current cycle and looks for some firming-up in steel demand late in the year.

△ This sage observation from Typo Graphic:

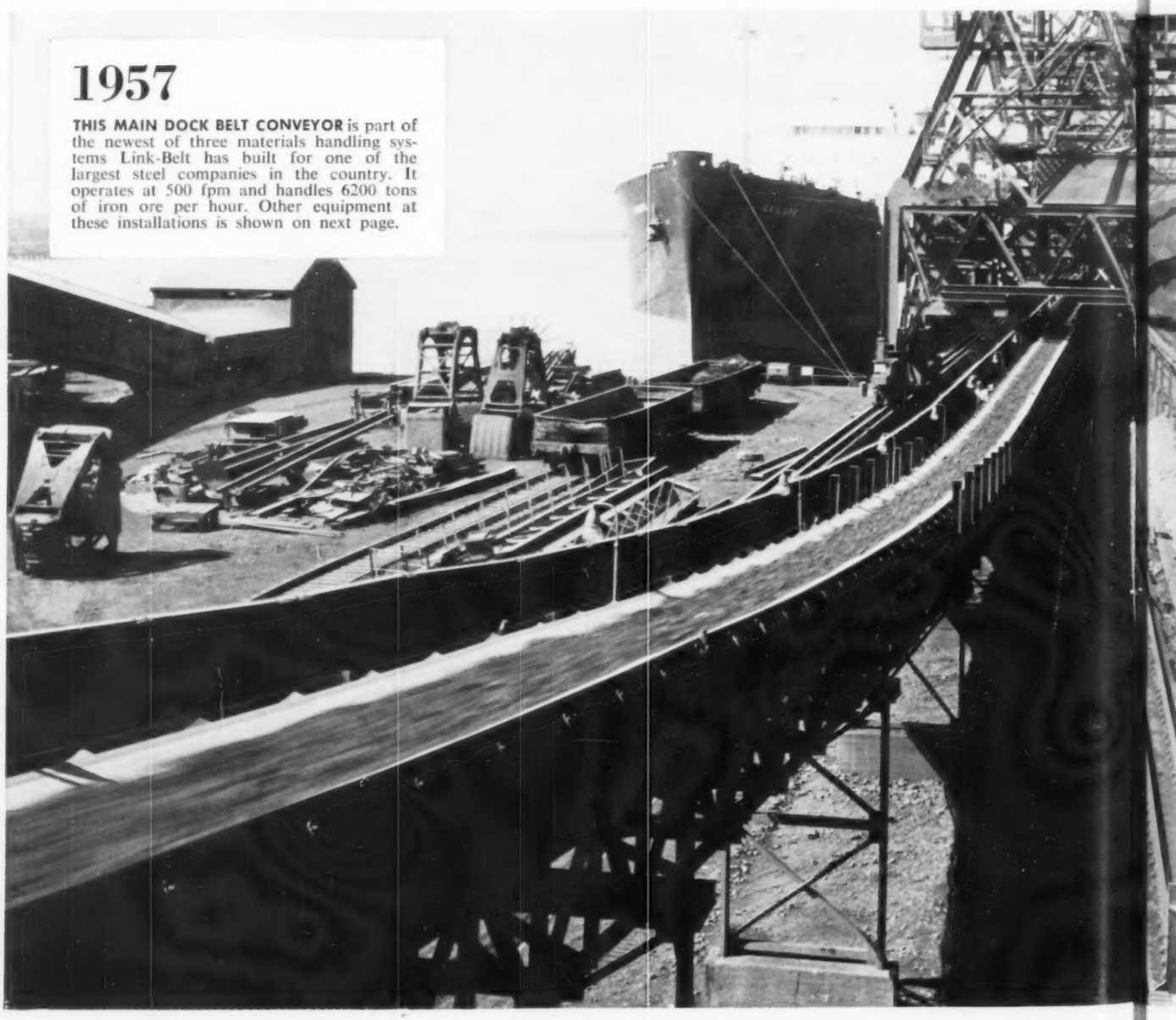
Why is it that a woman's mind
Will play such silly tricks?
She always thinks 5.95
Is so much less than six!

△ Shipments of finished steel products in 1957 totaled 79,894,577 net tons, fourth highest in the industry's history. Tonnages of principal products were cold rolled sheets, 11,879,354; plates 9,248,625; hot rolled sheets, 7,829,992; hot rolled bars, 7,567,400; structural, 6,817,796; and electrolytic tin plate, 4,676,482. Best customers were warehouses, automotive, construction and containers, in that order.

3rd Link-Belt handling

1957

THIS MAIN DOCK BELT CONVEYOR is part of the newest of three materials handling systems Link-Belt has built for one of the largest steel companies in the country. It operates at 500 fpm and handles 6200 tons of iron ore per hour. Other equipment at these installations is shown on next page.



system for 1 steel maker

LINK-BELT conveyors serve blast furnace areas at 3 eastern mills—handle raw materials from unloading, in and out of storage, to mill

Though modern blast furnace burdening techniques have multiplied problems of storing and reclaiming bulk materials, Link-Belt conveyors are cutting handling costs for steel mills throughout the country. The systems shown here are typical. So successful was the first installation for this steel company, Link-Belt twice more was called on to furnish complete facilities.

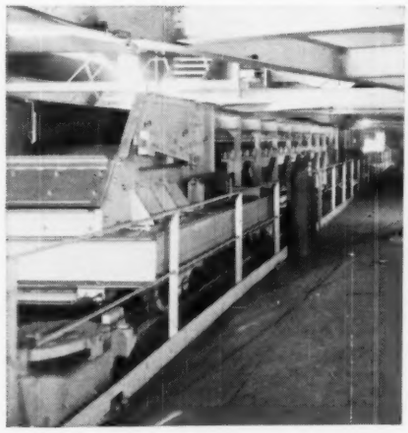
Link-Belt can bring similar efficiency—the same safe, high-capacity, low-cost handling—to every step of steel production in your plant. Link-Belt conveying systems are designed to make the most of existing space, adjust to increased capacities, fit into new processes. They simplify storage and reclaiming of raw materials . . . speed up production procedures . . . permit fast, easy intraplant movement of materials and products.

When relied upon for one-source service, Link-Belt accepts full responsibility for placing a system in successful operation . . . will work with your consultants and engineers to provide the best in modern handling of raw materials and steel in every form. For details, contact your nearest Link-Belt office.

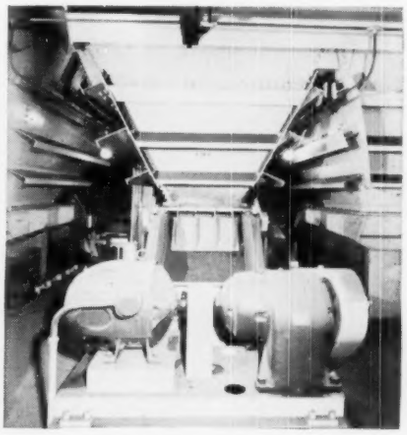
BELT CONVEYOR — 60-in. wide with 2000-ft. centers — is reversible to permit reclaiming as well as stockpiling of iron ore. It can handle 6200 tph when stocking out — reclaiming capacity is 2500 tph.

BELT CONVEYOR STACKER, typical of the unit furnished each installation, here delivers coal on the right and with boom positioned on the left stockpiles iron ore or limestone within range of bridge.

REVERSIBLE TRANSFER BELT CONVEYOR handles 6200 tph. Located in junction house, it can deliver ore either to conveyor going to screen house or to stocking out conveyor.



SHUTTLE BELT CONVEYORS deliver iron ore to six 1500-ton capacity blending and surge bins in screen house. These two conveyors are reversible. Each serves three bins and assists in blending ores.

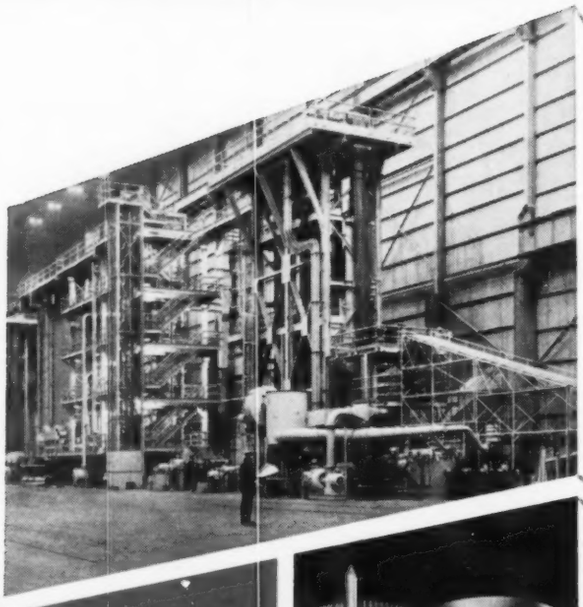


MANGANESE APRON FEEDERS under storage bins in screen house operate at 35 fpm and handle 500 tph. Each is powered by a 15-hp motor connected by flexible coupling to a Link-Belt drive.

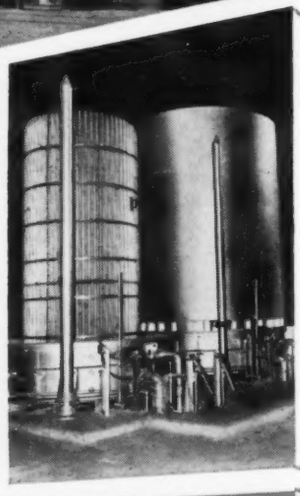
LINK-BELT

MATERIALS HANDLING, PROCESSING & POWER TRANSMISSION MACHINERY

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,785

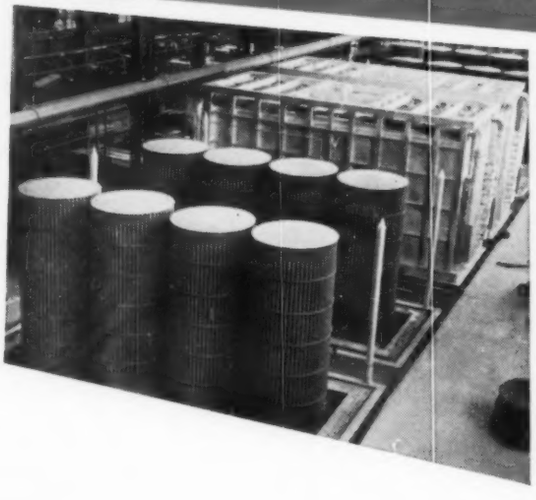


VERTICAL STRIP ANNEALER



SINGLE-STAND ANNEALERS

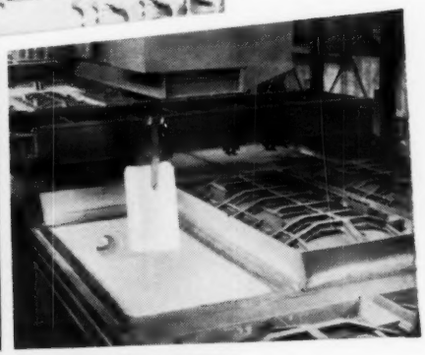
CONTINUOUS STRIP GALVANIZER



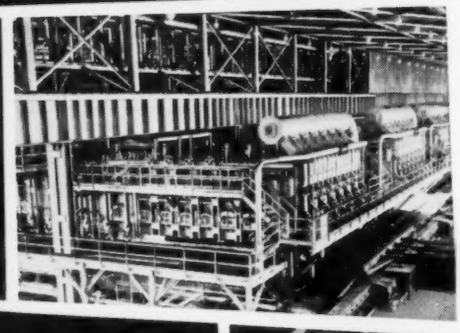
MULTIPLE-STAND ANNEALERS

foundation for steel mill profits

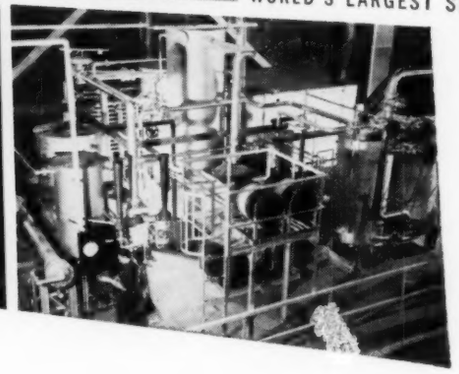
CARBOTTOM COVER FURNACE



ONE-WAY FIRED SOAKING PITS



WORLD'S LARGEST SLAB HEATER



HNX® GAS GENERATOR

You put a solid foundation under your profits whenever you specify Surface equipment. Whatever type it may be, you know it is supported by many interlocked blocks of know-how in heating and handling steel.

The technical skills which Surface has developed in building soaking pits will benefit the man who buys Surface annealing covers. In the same way, Surface concepts of slab heating contribute to high-speed stress relieving . . . carbon restoration to strip annealing . . . controlled atmospheres to wire patenting.

Because of this broad and deep foundation of experience, Surface can improve any single process in the context of a complete sequence of operations. This is to the customer's profit, as many companies will confirm.

Surface Combustion Corporation, 2404 Dorr St., Toledo 1, Ohio. In Canada: Surface Industrial Furnaces, Ltd., Toronto, Ontario.

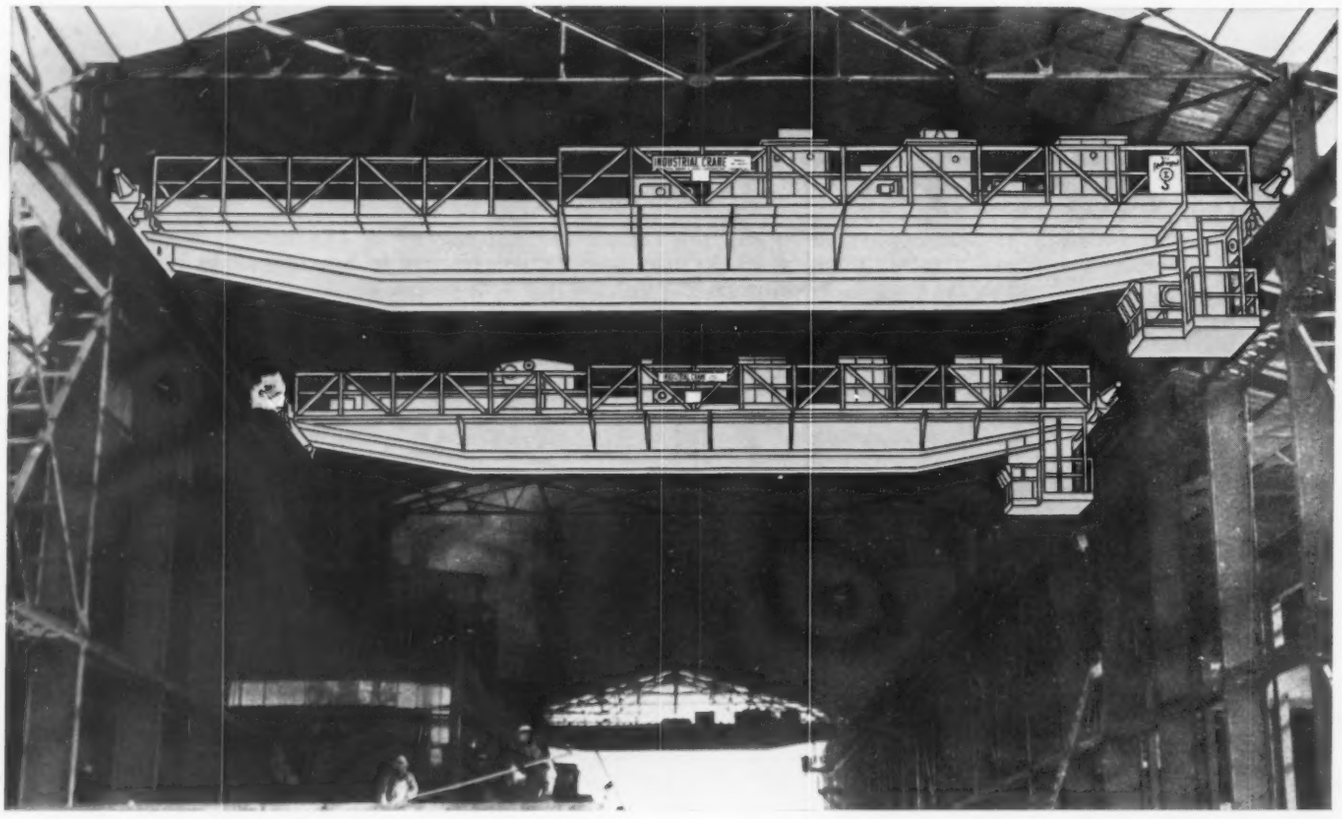
Surface®

wherever heat is used in industry

ASSOCIATED COMPANIES: British Furnaces, Ltd., Chesterfield • Stein & Atkinson, Ltd., London • Stein & Roubaix, Paris • S. A. Belge, Stein & Roubaix, Bressoux, Liege • S. A. Forni Stein, Genoa • Chugai Ro Kogyo Kaisha, Ltd., Osaka • Benno Schilde Maschinenbau, A. G., Bad Hersfeld

Industrial HEAVY DUTY CRANES

for rugged service, easy maintenance

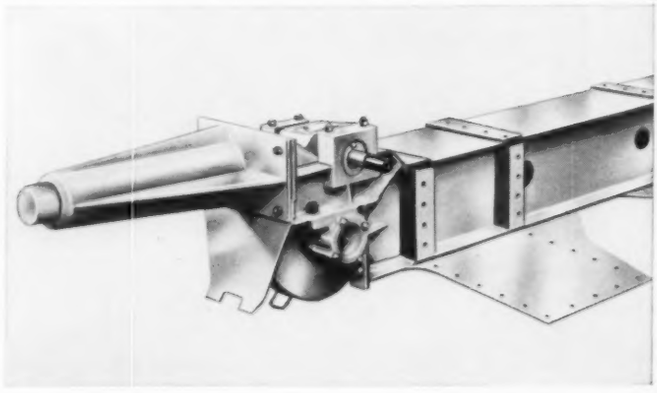


heavy box girder cranes have top performance features...

Industrial Heavy Duty Double Girder Overhead Cranes offer you today's best crane values because they're engineered and built to fit today's needs and operating conditions. Industrial features include:

- Rolled forged steel wheels.
- All steel welded M.C.B. roller bearing end trucks.
- Enclosed heat treated gears and pinions.
- All welded box girders with built-in camber.
- Fully decked trolleys and walkways.
- All operating components fully accessible for easy maintenance.

Industrial features like these give an extra margin of ruggedness for smooth operation under the severest operating conditions.



End truck assembly showing MCB roller bearing construction and fully enclosed gearing. Large squaring plates permanently align end trucks to box girders. Note accessibility of parts for most economical erection and maintenance.

It will pay you to consult with Industrial if your plans to build, enlarge or remodel call for overhead materials handling equipment. Remember . . . Industrial is best for the long run!

Find Your Nearest Dealer in The Yellow Pages

Dealers in principal industrial cities.

Industrial CRANES

INGERSOLL B-W BORG-WARNER

INDUSTRIAL CRANE & HOIST

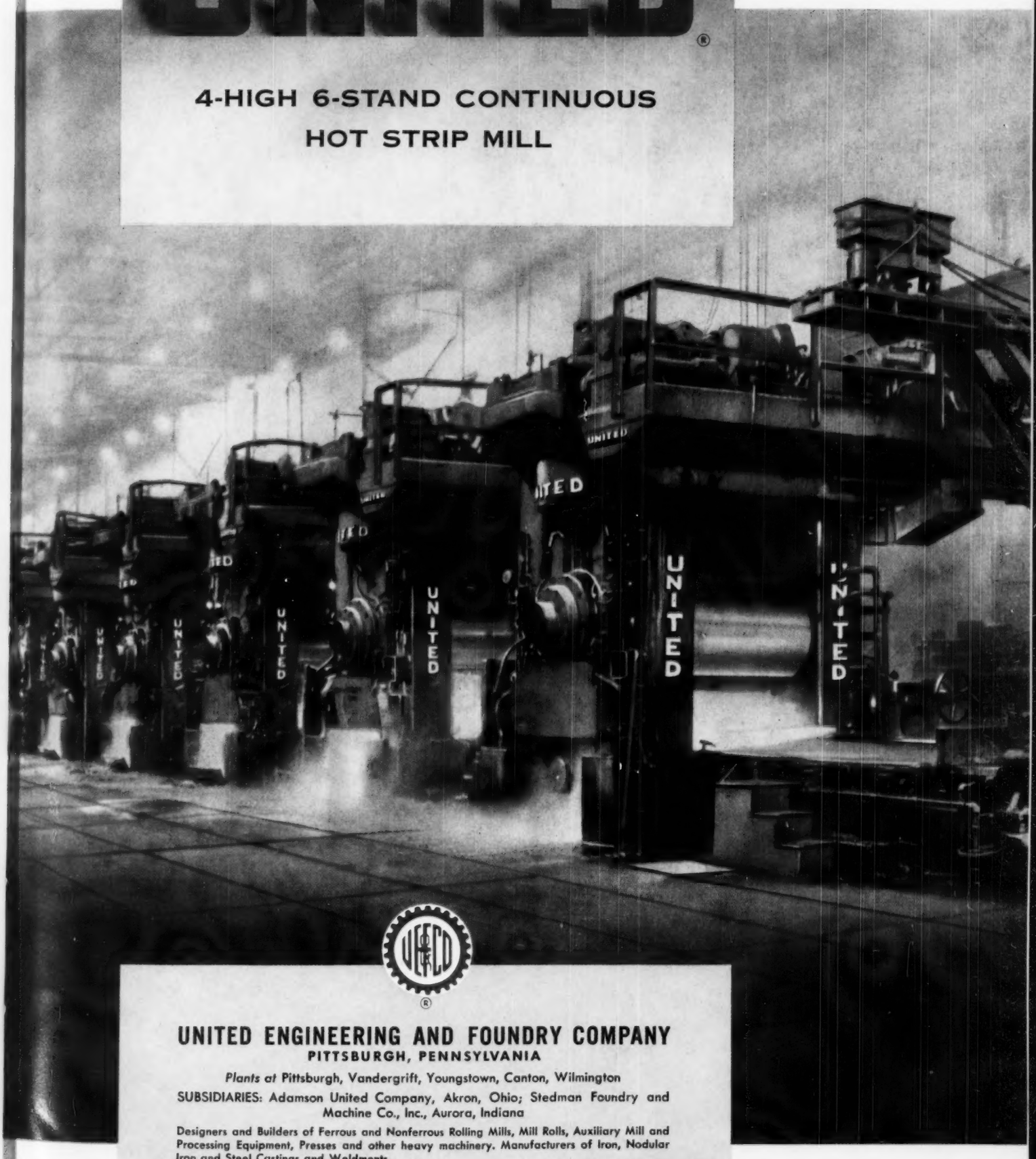
INGERSOLL PRODUCTS DIV. BORG-WARNER CORP.

1600 S. PAULINA STREET, CHICAGO 8, ILLINOIS

Export Sales: Borg-Warner International, 36 South Wabash Ave., Chicago 3, Illinois

UNITED®

4-HIGH 6-STAND CONTINUOUS HOT STRIP MILL



UNITED ENGINEERING AND FOUNDRY COMPANY
PITTSBURGH, PENNSYLVANIA

Plants at Pittsburgh, Vandergrift, Youngstown, Canton, Wilmington

SUBSIDIARIES: Adamson United Company, Akron, Ohio; Stedman Foundry and Machine Co., Inc., Aurora, Indiana

Designers and Builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other heavy machinery. Manufacturers of Iron, Nodular Iron and Steel Castings and Weldments.

HE CAN "MEASURE" MORE PROFIT FOR YOU. This Dowell service engineer can measure the amount of scale he removes from a line, using the Dowell method of chemical cleaning. *This removed scale and sludge can also be measured in increased profit dollars for your company.*

Example: Scale build-up in the main water supply line of a major Midwestern plant had reduced the "C" factor from 105 to 72. This situation became apparent just at the start of the peak season for the company. Management had a choice between laying an auxiliary line or trying to clean their present one. They decided to clean the line—but not the old-fashioned mechanical way. Time would not permit. Dowell was called in to do the job—chemically.

Dowell Service was fast—the job was done in three days. Dowell Service was effective—the "C" factor was increased to 92. Dowell Service was profitable for the customer—$71,000 was saved and the company's annual profit was protected.

With Dowell Service you receive the benefits of more than fifteen years experience in chemical cleaning—plus a full line of equipment, chemicals, and trained personnel. You pay one charge, get an efficient job, handled by experienced people.

Your maintenance and operating engineers probably know about Dowell Service. Ask them for the facts. Decide for yourself about the additional profit possibilities to your company with Dowell Service working for you. DOWELL INCORPORATED—A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY. Headquarters and research center, Tulsa, Oklahoma, with 165 offices and stations to serve you.

Chemical cleaning service for industry DOWELL

Well I'll be darned!

The amazing speed with which Berry Bearing Company consistently delivers orders has caused more than one surprised customer to exclaim--"Well I'll be darned!"--when his order was delivered only a few minutes after he phoned it in.

And, such unusually fast, efficient service is the rule--not the exception. In fact, for 37 years Berry Bearing has concentrated on making immediate delivery on *every* order.

To do so, over 50,000 bearings, bearing specialties, and transmission appliances are regularly carried in stock. Thus, filling orders is relatively simple. In addition, Berry has 6 locations strategically situated throughout the Chicagoland industrial area. The result is--no customer is more than 5 miles away. Consequently, making delivery in approximately 27 minutes is comparatively easy.

Like thousands of other bearing users--you can get exactly what you want...and...get it fast--from Berry Bearing Company. Why not phone now for *anything* you need?

ANTI-FRICTION BEARING DISTRIBUTORS ASSOCIATION · MEMBER AFBDA

BERRY BEARING COMPANY

All phones--DAnube 6-6800

2633 S. Michigan Ave. • • • • Chicago 16, Illinois

SOUTHWEST	OAK PARK	SKOKIE	ROCKFORD	HAMMOND	GARY
6923 W. Archer Ave.	327 Madison St.	4438 Oakton St.	710 Broadway	4828 Calumet Ave.	716 E. 5th Ave.
LUdlow 5-4400	EUclid 6-1700	ORchard 4-6600	Phone 2-5561	WEstmore 1-3010	TUrner 5-7501

With Thermalloy* Furnace Rolls, nobody lays an
egg
When you find your furnace rolls are egg-shaped, sagging or warped before their time, consider these facts:
Thermalloy Furnace Rolls have the highest degree of concentricity and true roundness modern metallurgy has ever developed! Electro-Alloys centrifugally casts these furnace rolls so they will have greater density and finer grain structure. They are strong enough to withstand the punishment they receive in modern steel mills.
It will pay you to call your nearby representative—or write Electro-Alloys Division, 8006 Taylor St., Elyria, Ohio.
*Reg. U. S. Pat. Off.
AMERICAN Brake Shoe COMPANY
ELECTRO ALLOYS DIVISION
Elyria, Ohio

patent reviews

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents . . . . patents reviewed cover period October 1, 1957 through October 29, 1957.

DEOXIDATION OF STEEL WITH ALUMINUM BASE ALLOY

△ U. S. 2,808,327, issued Oct. 1, 1957 to Earl W. Pierce, assigned to U. S. Reduction Co., describes a process for the deoxidation of steel whereby the occurrence of slivers in sheets rolled from the steel is materially reduced.

The invention consists of the addition to molten steel of a deoxidizing agent composed largely of aluminum, which reacts with it somewhat explosively and thus causes a more uniform distribution and solution of the aluminum. The use of an alloy of aluminum containing zinc (3 to 5 per cent) and magnesium (1.75 to 3 per cent), produces this result, without making the reaction too violent.

The addition agent is used in the same manner as aluminum is used at present for deoxidizing low-carbon steel.

REMOVAL OF PHENOL FROM BY-PRODUCT COKE WASTE WATERS

△U. S. 2,808,375, issued Oct. 1, 1957 to Dan P. Manka, assigned to Jones & Laughlin Steel Corp., relates to the removal of phenol from waste waters discharged from plants engaged in the by-product coking of coals, in order to prevent stream pollution.

The process consists of treating the waste waters with a mixture of an aromatic hydrocarbon solvent and dehydrobietylamine. The phenols dissolve in the solvent and are reduced to as low as 2 to 10 ppm.

The patent describes a method of recovering the solvent, and recovering the phenol as sodium phenolate.

INGOT MOLD MATS

△ U. S. 2,807,846, issued Oct. 1, 1957 to Harrison D. Sterick and William E. Schmertz, relates to protective mats designed to be placed in the bottom of ingot molds.

A mat is provided by coiling together two or more strips of metal of different widths, as shown in Figures 1 and 2. The strips are preferably arranged in such a way that the bottom edges of all of the strips are in a plane making a mat having a substantially flat, solid bottom, while the top of the mat is provided with a groove or grooves formed between the convolutions of the strips. Such a mat more effectively reduces the splash of the metal and erosion in the bottom of the mold. Also it provides considerable extended or fin area for conducting heat from the molten metal into the base of the mold or mold stool, while the substantially flat base of the mat provides a large area of heat contact between the mat and the bottom of the mold or the mold stool. Not only is such a mat highly effective, but it has the further advantage of reducing the over-all weight of the mat, in that by making one of the strips narrower than the other, a substantial amount of metal can be eliminated, while giving increased effectiveness. These mats not infrequently have diameters of sixteen inches or more, and the reduction in over-all weight is a substantial factor.

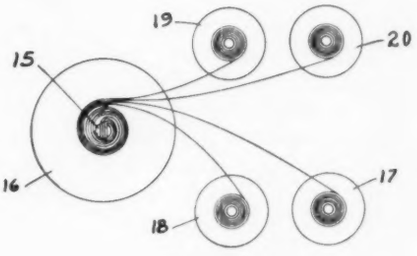


Figure 1

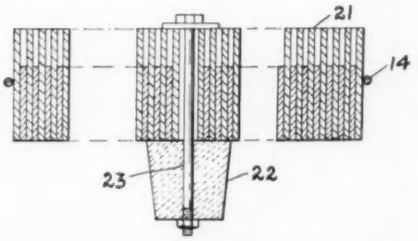


Figure 2

METHOD OF MELTING FERROUS METALS

△ U. S. 2,808,326, issued Oct. 1, 1957 to Thomas G. Bowers and assigned to Great Lakes Carbon Corp., relates to a method for melting ferrous metals, in which a charge consisting of a novel type of foundry coke is used. The result is to double the melting rate over standard foundry coke. Furthermore, the carbon content of the final metal product is substantially increased without impairing other properties of the metal such as hardness, tensile strength, silicon and manganese content, etc. Also, a marked reduced occlusion of gases in the final metal occurs, as well as greater fluidity of the metal as it leaves the cupola.

The components of the coke are:

(a) a major portion of petroleum coke having a volatile content between about 5 and about 14 per cent by weight; (b) between about 5 and about 15 per cent by weight of anthracite; (c) between about 10 and about 30 per cent of a hydrocarbon pitch; (d) the balance consisting essentially of a swelling bituminous coal having a volatile content between about 14 and about 22 per cent. The major portion of this mixture, preferably 90 per cent, should pass a ¼-in. screen.

The above mixture is placed in a by-product oven. The oven is normally loaded through the top port with the coal mixture filling the oven to about three-fourths of its height. The mixture is then coked in indirect heat generated by the combustion of gases in the flues, the interior of the ovens being at temperatures of between about 1800 to 2200 F. The coking cycle will usually depend mainly upon the ultimate properties desired in the coke and upon the temperatures of the flues. Thus at a final oven temperature of 1800 F, the cycle will require from between about 20 to 25 hr and at 2200 F will require between 18 to 20 hr.

IRON RETENTION AND SLAG REGULATING PIT

△ U. S. 2,809,028, issued Oct. 8, 1957 to Selwyne P. Kinney and Fred Osborne, describes an apparatus for the cellulation of blast furnace slag to produce a hard, strong light weight aggregate for use as fill or as a substitute for gravel in concrete construction. More specifically, it relates to a form of iron rentention and slag flow regulating pit for feeding the molten slag to the cellulating apparatus.

The pit, as shown in Figure 3 is of a suitable size to handle the slag discharge from one or more furnaces. The side walls 9 and end walls 10 of the pit may be of any suitable material such as concrete, and the bottom 11 may be formed of the same or other suitable materials. At the bottom of the pit between the side walls 9 is a dam or partition 12 extending up from the bottom 11, dividing the pit into chambers A and B, the chamber A forming the iron retention part of the chamber of the pit, and the chamber B forming the slag flow control portion of the pit. The side and end walls, bottom and partition of the pit are lined with a heat-resistant material such as firebrick 13. Within the chamber A and extending through the end wall 10 near the top of the chamber is opening 15 through which is discharged the contents of the cast slag runner and any iron mixed with it. Within either the chamber B or chamber A, and extending through the adjacent pit side wall 9, is another opening 16 through which is fed the flush slag from the runner for the cellulating apparatus. The firebrick at the bottom of the pit and at the exposed surfaces of the dam 12 are provided with a lining 14 of fire clay disposed over the firebrick. The bottom portion of the chamber A slopes downwardly from the dam 12 towards an iron outlet 17. The bottom portion of the chamber B slopes downwardly and outwardly from the dam 12 towards its outlet 18. A slag overflow opening 19 in a side wall 9, below the level of the openings 15 and 16 is disposed between the chambers A and B near the dam 12. The bottom openings 17 and 18 of the pit chambers A and B respectively have associated therewith the conventional devices known as "monkeys" for controlling the flow of the metal or slag from these chambers. A runner 20 connects opening 17 in chamber A with a pit to receive the entrapped iron and a runner 21 connects opening 18 in chamber B with the cellulating apparatus.

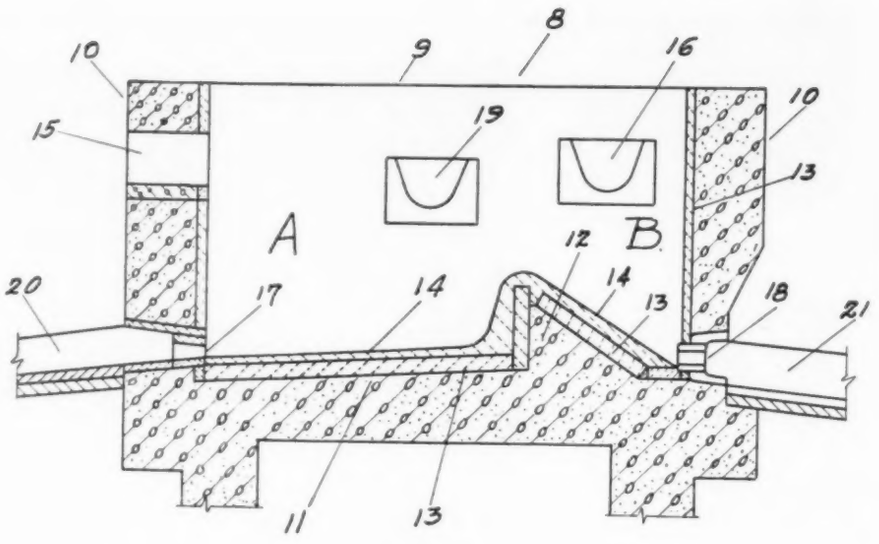


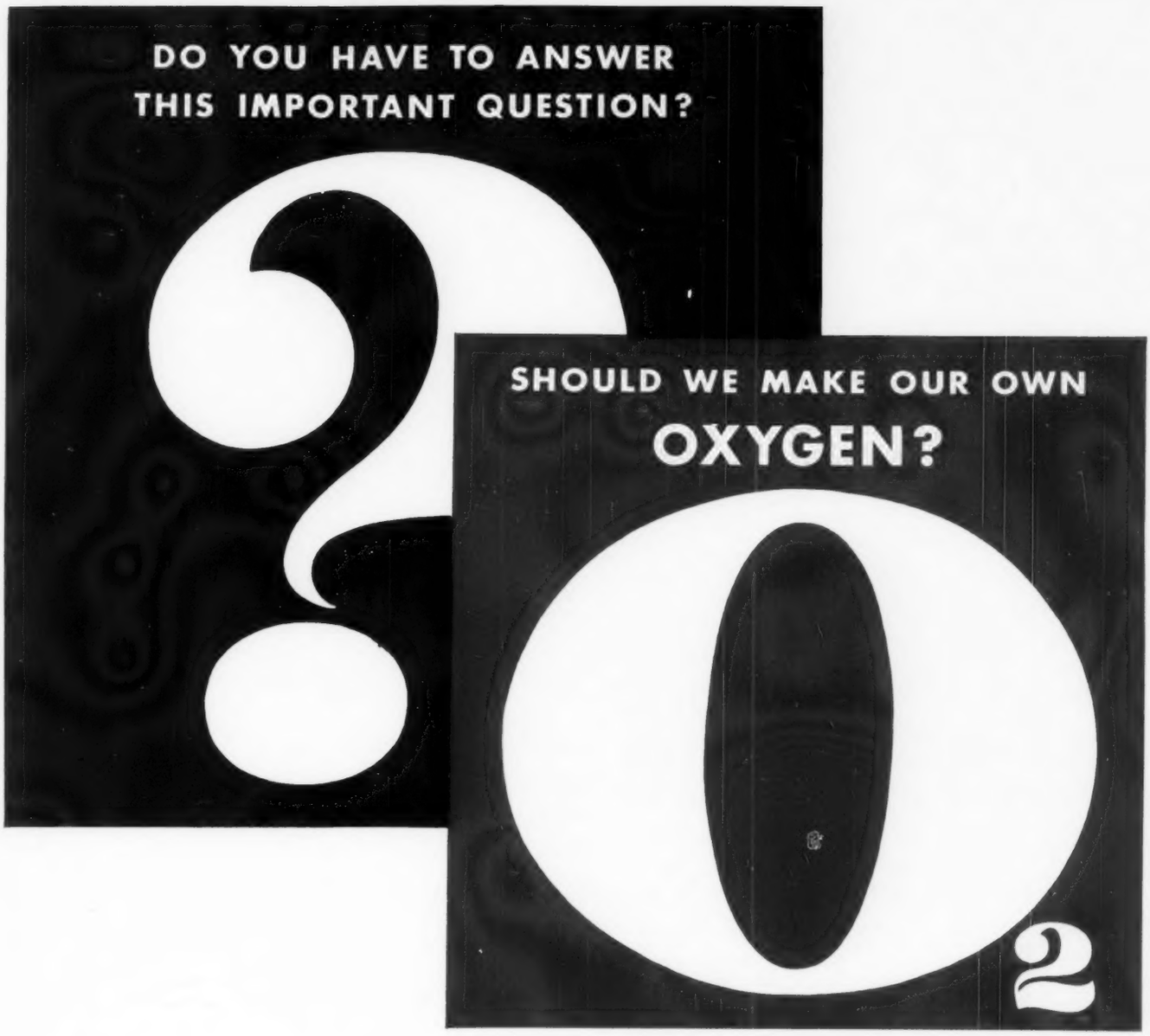
Figure 3

In operation, the cast slag runner feeds the molten slag and entrapped iron into chamber A through opening 15. The iron being heaviest falls to the bottom of chamber A and is drawn off through opening 17. The molten slag floats on the iron in chamber A, and as the chamber fills the slag flows over dam 12 into chamber B. The iron-free, or flush slag, may be discharged into pit chamber B and the contents of chamber B flows through opening 18 into runner 21 and to the cellulating apparatus.

RECOVERING IRON VALUES FROM BLAST FURNACE DUST

△ U. S. 2,810,633, issued Oct. 22, 1957 to Jack Ellis Cooper, describes a process for recovering iron values from blast furnace dust.

As shown in Figure 4, the combined flows of dust laden water from the blast furnace wet washer, disintegrator and Cottrell precipitator are emptied into mixer 10. While being intensively agitated in mixer 10, pickle liquor containing ferrous sulphate and sulphuric acid is slowly added. The agitating apparatus employed in mixer 10 is preferably one which is capable of inspirating air into the liquid being mixed. It is essential for this mixing operation that the pickle liquor be added slowly so that at no time does the concentration of caclium sulphate produced by the interaction of the calcium carbonate in the blast furnace dust and the free acid in the pickle liquor exceed the solubility of calcium sulphate in the existing liquid. In this mixer the natural alkalinity in the incoming water as well as the alkalinity available from the iron, lime and magnesium compounds from the blast furnace serve



More and more manufacturers are considering this question today, as the use of oxygen in industry continues to expand.

GET THE STRAIGHT ANSWER

As a leading supplier of oxygen-producing plants to all industries, Messer can give you an authoritative and unbiased answer to your own specific inquiries into this problem. In many cases, it may be more economical to purchase oxygen from reliable gas producers. If this is true in your case, Messer will tell you so.

But if your demands are such that you could profitably install your own bulk oxygen producing equipment, Messer's broad experience can help to assure you of the most efficient plant for your particular needs. We will welcome an opportunity to talk with you.

AMERICAN MESSER CORPORATION

CHRYSLER BUILDING • 405 LEXINGTON AVENUE • NEW YORK CITY

"There Is No Substitute for Messer Experience"

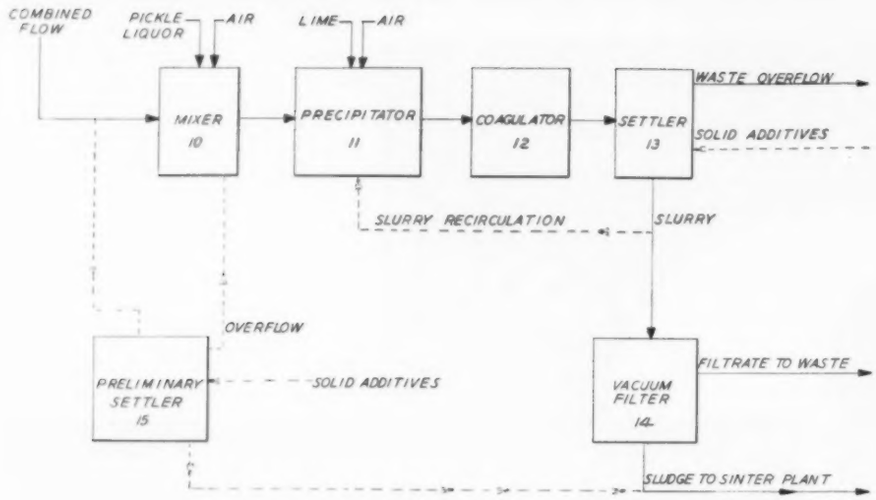


Figure 4

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

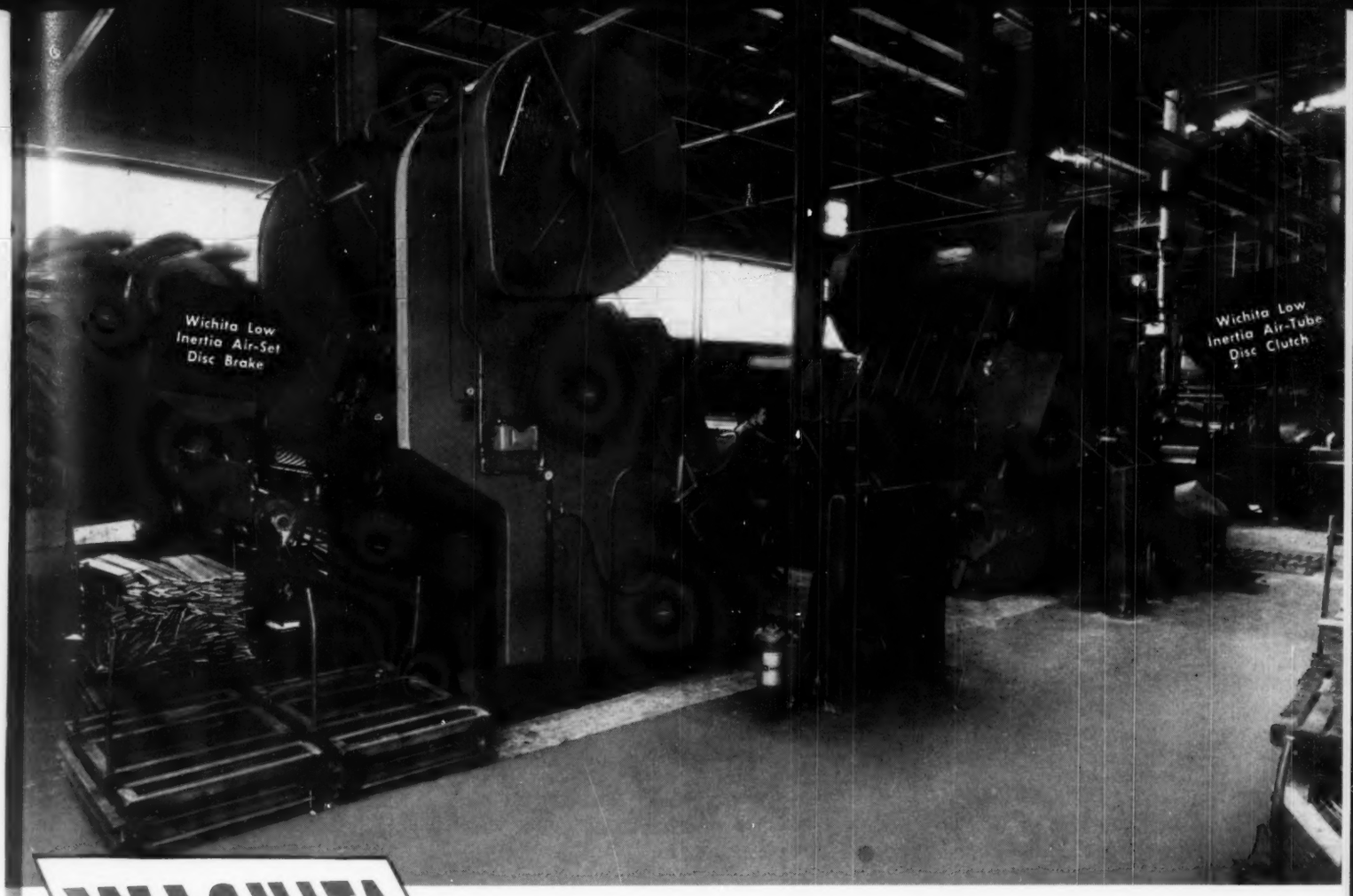
Patent No.	Date	Subject	Inventor or assignee
2,808,081	10/1/57	Rocker cradle for nail boxes	United States Steel Corp.
2,808,104	10/1/57	Flying shears for cutting traveling stock from rolling mill	Birdsboro Steel Foundry & Machine Co.
2,808,325	10/1/57	Agglomeration of ore fines or blast furnace dust with a heavy hydrocarbon pitch	Metal Suberdop S.A.
2,808,353	10/1/57	Heat treatment of chromium alloy steels preparatory to deep drawing operations	Sharon Steel Corp.
2,808,642	10/8/57	Method of making a coil of wire	United States Steel Corp.
2,809,105	10/8/57	Removal of chromium from Mayari type iron ore	Bethlehem Steel Co.
2,809,106	10/8/57	Sintering iron ore with coke oven refuse	Jones Coal & Coke Co.
2,809,109	10/8/57	Treatment of highly alloyed hypereutectoid steel	Bethlehem Steel Co.
2,809,319	10/8/57	Automatic control of electric arc furnaces	The British Thomson-Houston Co. Ltd.
2,809,336	10/8/57	Motor control system for twin drive reversing hot mill	Westinghouse Electric Corp.
2,809,542-3	10/15/57	Compensating system for hydraulic presses	Baldwin-Lima-Hamilton Corp.
2,809,545	10/15/57	Arrangement for rolling straight bars at high rolling speeds	Sven E. M. Norlindh
2,809,819	10/15/57	Fuel atomizer for steel furnace	Walter R. Losada
2,809,822	10/15/57	Heat treating muffle furnace	John R. Gier, Jr.
2,809,886	10/15/57	Plunger for introducing volatile substances into molten metal	The International Nickel Co. Inc.
2,809,888	10/15/57	Production of cast iron with high creep resistance	The International Nickel Co. Inc.
2,810,450	10/22/57	Apparatus for treating coke oven gas	Allied Chemical & Dye Corp.
2,810,480	10/22/57	Apparatus for reciprocating strips or belts	United States Steel Corp.
2,810,566	10/22/57	Shield and feed control for mining machine of the screw auger type	United States Steel Corp.
2,810,570	10/22/57	Reeling apparatus for cooling hot rod	Morgan Construction Co.
2,810,667	10/22/57	Heat-treating in a protective atmosphere	Siemens & Halske Gesellschaft m.b.H.
2,811,010	10/29/57	Preforming head for wire stranding machine	United States Steel Corp.
2,811,060	10/29/57	Planetary reducing mills	Tadeusz Sendzimir
2,811,345	10/29/57	Blast furnace hopper with leveling adjustment	United States Steel Corp.
2,811,424	10/29/57	Apparatus for the recovery of ammonia from coke oven gas	Koppers Co., Inc.
2,811,433	10/29/57	Treatment of iron powder or sponge iron with gaseous hydrogen chloride	Republic Steel Corp.
2,811,438	10/29/57	Method for overcoming embrittlement of steel alloys	Electric Steel Foundry Co.
2,811,473	10/29/57	Method of increasing surface resistivity of silicon steel	United States Steel Corp.

to at least partially neutralize the acidic constituents of the pickle liquor. The free acid in the pickle liquor will be first neutralized, with the resultant production of carbon dioxide. The air added to this mixer 10 serves the purpose of scrubbing the carbon dioxide from the mix as well as partially oxidizing any iron hydrates which may be precipitated at this stage. The removal of carbon dioxide permits the neutralization of more of the acidic constituents in the pickle liquor by the calcium carbonate and bicarbonate available in mixer 10.

It is difficult in mixer to raise the pH of the liquid to a value between 7 and 8, which is necessary for the quantitative precipitation of the iron compounds. Accordingly, the liquor from mixer 10 is flowed to a precipitator 11 which may be structurally similar to mixer 10. Here calcium hydroxide, perferably in the form of slurry, is slowly added. The agitation in precipitator 11 is accompanied by intensive aeration again to remove carbon dioxide from the slurry and to oxidize precipitated ferrous hydrate to ferric hydrate. The oxidation of ferrous to ferric iron in this very dilute solution proceeds quite well and yields a precipitate much more amenable to the subsequent steps of coagulating, settling and filtering. A typical time in mixer 10 and precipitator 11 would be two to five minutes each.

The effluent from precipitator 11 is quite free of soluble iron and is passed to coagulator 12. In this vessel the material is very gently agitated for a period of time of about twenty minutes. During the residence in the coagulator, the precipitated iron hydrates and the iron oxides, lime compounds and coke carried over from the blast furnace co-act to produce a mass which will settle in a practicable length of time and which will produce a sludge which can be handled on a vacuum filter.

The effluent from coagulator 12 is conducted to any conventional quiescent settling apparatus of which the Dorr thickener is a typical example. The size of the thickener is selected so that the residence of the material therein will be sufficiently protracted to produce an effluent having a solids content below the desired minimum. In most cases it is possible to produce an effluent from



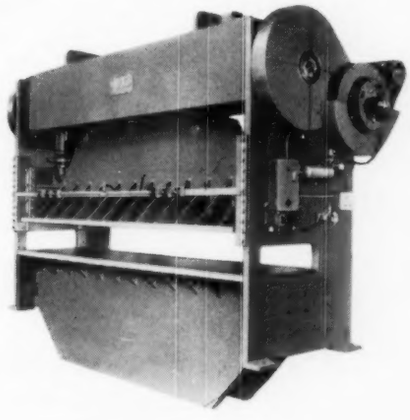
WICHITA Clutches & Brakes

"MEAN SMOOTHER, MORE CONSISTENT and TROUBLE-FREE OPERATIONS . . ."

Dreis & Krump Manufacturing Co., Chicago, Illinois

"We find Wichita offers many important advantages to make our presses more efficient such as: Faster Operation; the Lowest Moment of Inertia; Positive Ventilation for Cooler Running; and Smoother, More Consistent and Trouble-free operation." Pictured above are two 400-ton capacity presses, with 8′ beds, which are utilizing Wichita Clutches and Brakes. These machines are used for punching and trimming steel strips. The 200-ton capacity press at right, has a 4′ x 16′ bed and also utilizes Wichita Units. This press is used for punching and notching refrigerator shell blanks."

Wichita Low Inertia Air-Tube Disc Clutch



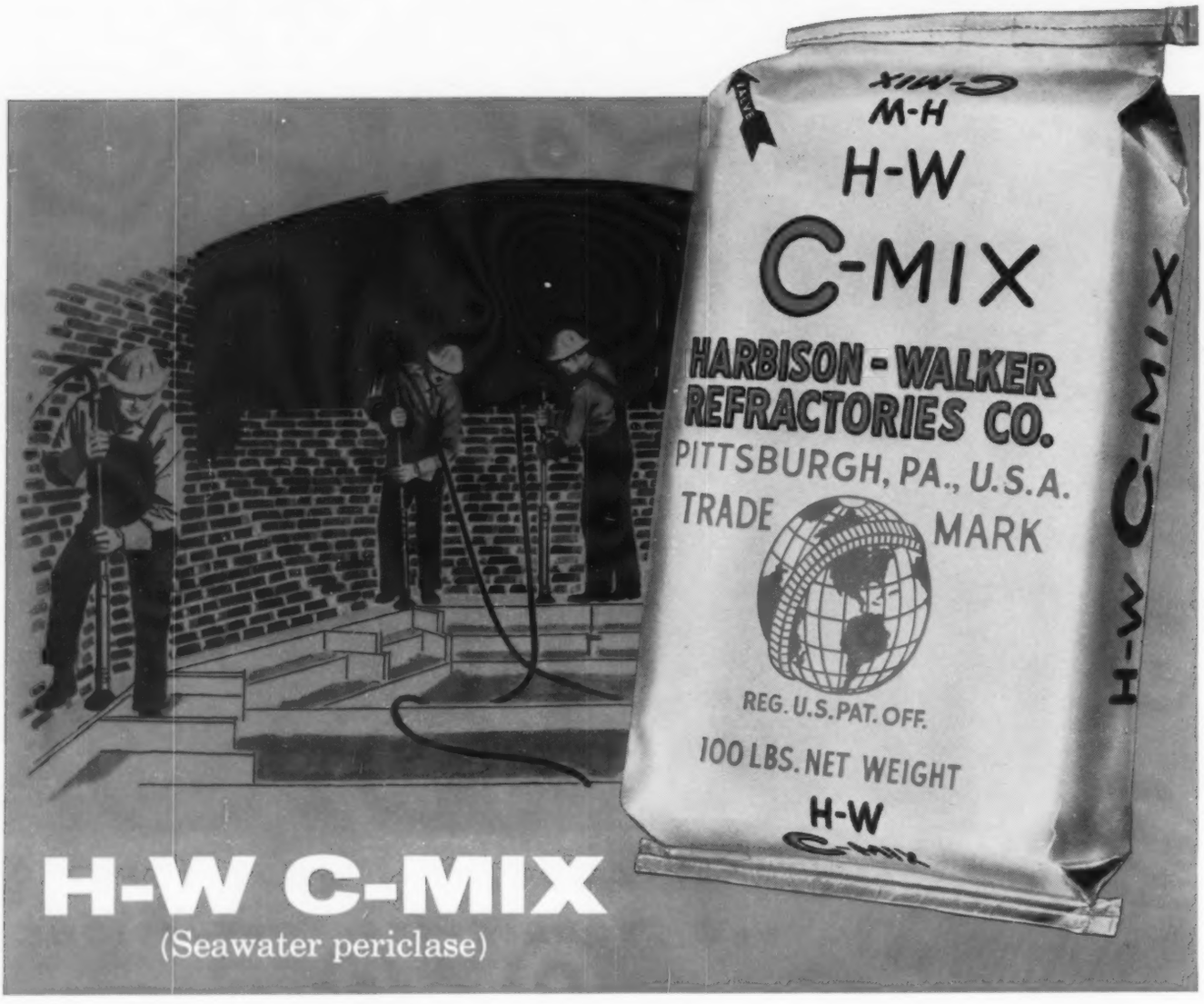
Wichita Low Inertia Air-Set Disc Brake

Do the best for your Presses, Press Brakes and Shears— by equipping them with Wichita Units.

WICHITA Clutch COMPANY, INC.
WICHITA FALLS, TEXAS, U.S.A.

Contact your nearest Wichita Engineer!

Brehm-Lohner, Inc., Detroit, Michigan
E. H. Fremont, Cincinnati, Ohio
W. G. Kerr Company, Pittsburgh, Pa.
Smith-Keser & Co., Avon, Conn.,
Philadelphia 44, Pa., and New York, N. Y.
Frank W. Yarline Co., Chicago, Illinois
Harry W. McDowell, Long Beach, California
Andrew T. Lobel, Denver, Colorado
Robert R. King Co., Cleveland, Ohio
Allied Transmission Equipment Co., Kansas City 8, Missouri
Donald E. Harmon, Dallas, Texas
C. Arthur Weaver, Richmond, Virginia
Malcolm S. Cone, Memphis, Tennessee
Dominion Power Press Equipment, Ltd., Burlington, Ontario, Canada
R. E. Kunz, Seattle 4, Wash.
W. G. Ballantyne Co., Portland 4, Ore.



Operating records show unmatched benefits!

H-W C-MIX used for contour-rammed open hearth and electric steel furnace bottoms greatly reduces furnace down-time, saves labor and avoids burning-in sacrifice of refractory superstructure. And with its measurable margin of superior properties, costs are decidedly lower and furnace availability is greatly increased.

- **HIGH MAGNESIA CONTENT**—Made from high purity seawater periclase with the magnesia content over 92%, H-W C-MIX best withstands the corrosive action of highly basic slags.
- **STABLE**—It is fully converted to periclase and has excellent volume stability with negligible shrinkage at highest operating temperatures.
- **HYDRATION RESISTANT**—H-W C-MIX is unique in its high degree of resistance to hydration.
- **STRONG**—High strength over the entire range of steel furnace temperatures accounts for its unusual resistance to erosion.
- **DENSE**—High density and low permeability retard penetration by molten metal and corrosive slags.
- **ECONOMICAL**—H-W C-MIX provides the most durable monolithic hearths with low installation cost.

World's Largest Producer of Refractories

HARBISON-WALKER REFRACTORIES COMPANY
AND SUBSIDIARIES
General Offices: Pittsburgh 22, Pennsylvania

settler 13 having a solids content below 10 ppm. An effluent of this caliber may be added directly to streams with no adverse effects.

The under flow or slurry produced by settler 13 is conducted to vacuum filter 14. This vacuum filter may be any of the well known continuous rotary vacuum filters. A particularly satisfactory filter for this separation is known as the string or Feinc filter. Any of these devices will produce a substantially clear filtrate and a sludge having a water content between fifty and eighty per cent, which is sufficiently dense to enable its transportation by conveyor to a sintering plant. Here it may be sintered along with the dry pulverulent solids recovered from the blast furnace gas by the dust catcher.

METHOD OF REMOVING SALAMANDER FROM BLAST-FURNACE HEARTH

△ U. S. 2,810,634, issued Oct. 22, 1957 to Leonard Tofft, assigned to United States Steel Corp., describes a method of removing the salamander or pool of molten iron which accumulates on the bottom block of the blast furnace in the cavity formed by erosion of the original hearth surface.

The inventor describes his method as follows: "I increase the angle of depression of the tap-hole with the horizontal in steps for several days prior to blowing out, and use excess clay in plugging the hole after each cast as needed, to maintain the tap-hole length substantially constant. Then, when the time for blowing out arrives, I alter the burden by charging an unusually heavy layer of coke and thereafter, alternate layers of coke and sinter or other filler material. I then continue to blow and charge the furnace, controlling the charging rate so that, when the heavy coke layer descends below the level of the tuyeres, the stock column has a height above the mantle substantially greater than normally existing on blowing out, thus maintaining the normal blast pressure and volume substantially undiminished. Then after the heavy coke layer has descended below the level of the tuyeres, I make the final cast of molten iron from the furnace. On this cast, the greater portion by far of the salamander is forced out of the tapping hole by the blast pressure above the hearth."

TREATMENT OF FUMES IN STEELMAKING OPERATIONS

△ U. S. 2,811,435, issued Oct. 29, 1957 to Leonard C. Bannister and William J. B. Chater, assigned to The British Oxygen Co. Ltd., describes a method for the treatment of fumes arising during the treatment of molten iron with oxygen.

There have been various prior suggestions for the removal of these fumes. In some works this is brought about by installing a special plant to suck the fumes into suitable vessels where the iron oxide is removed either by scrubbing with water or by electrostatic precipitation. Such methods are inevitably rather costly and are a deterrent in the development of processes which involve the use of oxygen.

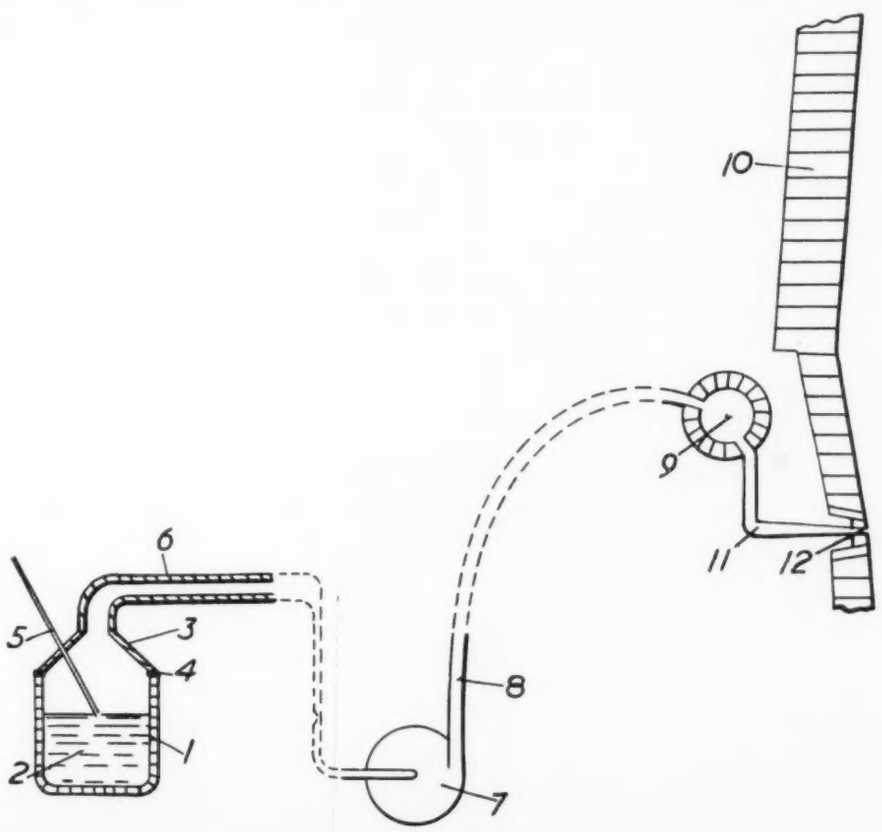
It is the object of the present invention to provide a method of and apparatus for removing and disposing of these fumes, for utilizing the iron which they contain in suspension and also for utilizing any excess oxygen which may also be present.

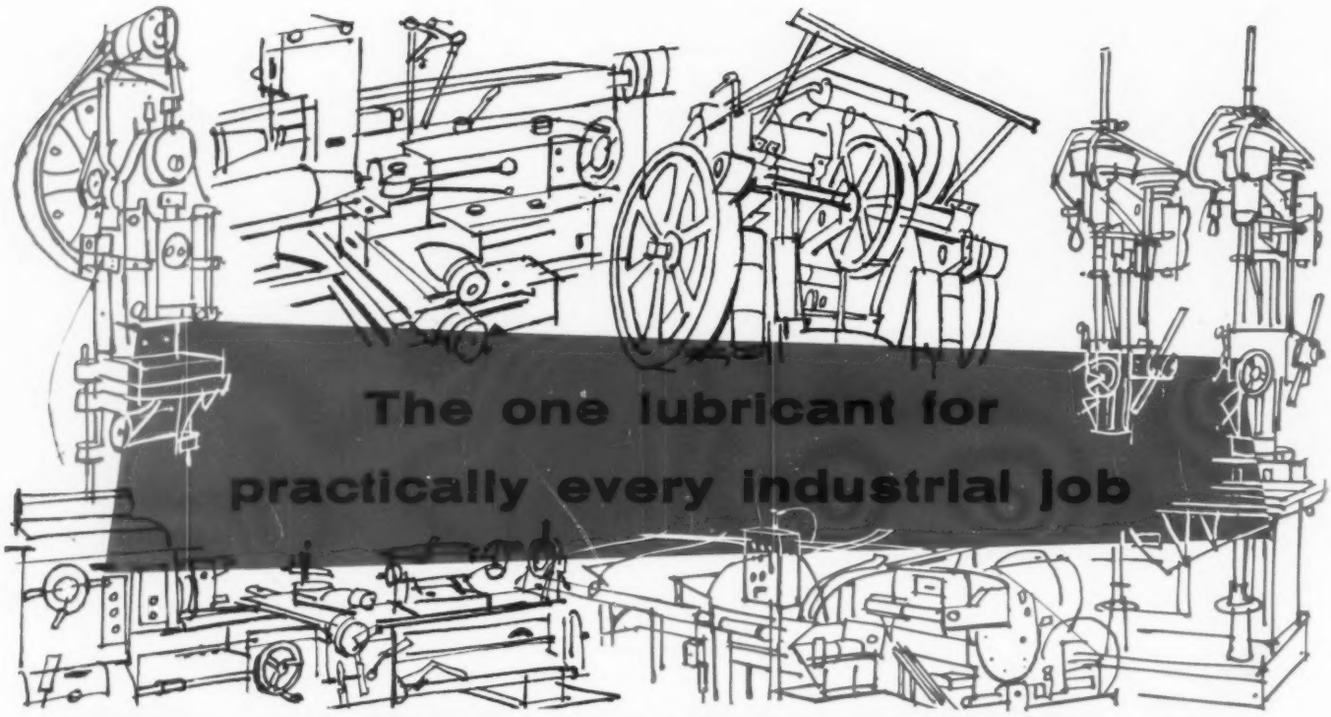
As shown in Figure 5, the ladle 1 containing the molten iron 2 is provided with a conical hood 3, the circumference of the hood being joined to the rim of the ladle in substantially gas-tight manner by a refractory seal 4. An oxygen lance 5 for directing a jet of oxygen or oxygen-enriched air against the molten iron, passes through the wall of the hood 3. A conduit 6 opens at one end into the apex of the hood 3 and is connected at the other end to the inlet of a blower 7. The outlet of the blower 7 is connected by a further conduit 8 with the bustle pipe 9 of a blast furnace, a part of the wall of which is indicated at 10. From the bustle pipe 9, the usual pipes 11 for conducting the blast lead to tuyeres 12 in the wall of the blast furnace.

RECOVERY OF AMMONIA FROM COKE OVEN GAS

△ U. S. 2,811,424, issued Oct. 29, 1957 to Joseph van Ackeren, assigned to Koppers Co., Inc., describes an apparatus for the concurrent absorption in sulphuric acid solution of ammonia from coke oven gas, and the crystallization of the resulting ammonium sulphate from the absorbent solution, producing large crystals without excessive capital investment.

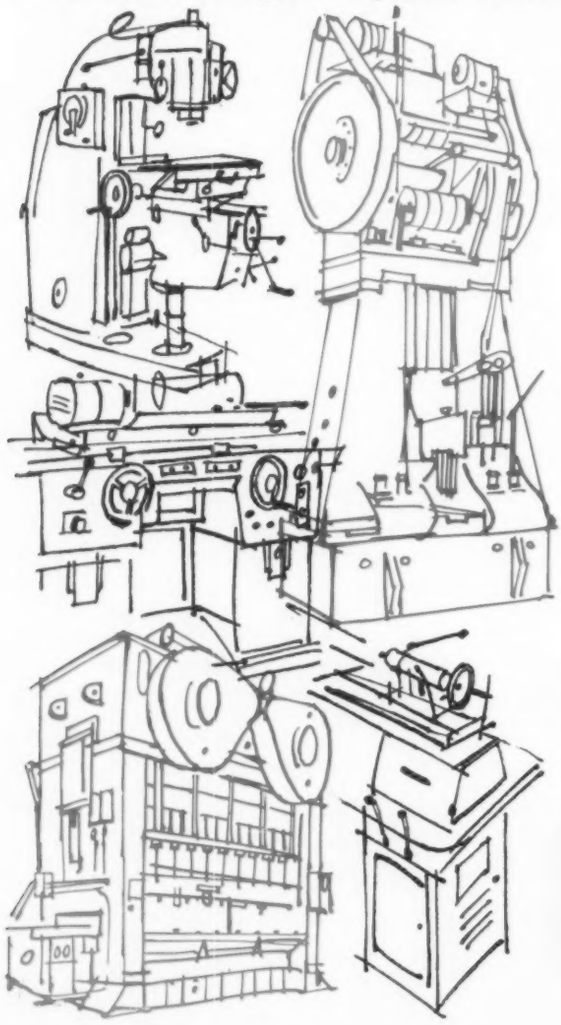
Figure 5





ATLANTIC LUBRICANT 54

Performs on all types of grease-lubricated machinery • Cuts cost • Reduces lubricating errors



Atlantic Lubricant 54—an outstanding multi-purpose lubricant—assures:

- **Wider application**—almost universal application to grease-lubricated equipment in plants of all sizes
- **Excellent performance** at very high to extremely low operating temperatures
- **Reduced losses** from lubricating error
- **Lower costs** of warehousing and handling
- **Outstanding rust protection** for all ferrous surfaces
- **Unusual stability** against oxidation and softening—even under very rugged conditions
- **Easy, positive identification**—thanks to Atlantic Lubricant 54's distinctive purple color

Available from conveniently located warehouses. Call any of the Atlantic offices listed below.

ATLANTIC

LUBRICANTS • WAXES
PROCESS PRODUCTS

PHILADELPHIA, PA.
260 So. Broad St.

PITTSBURGH, PA.
Chamber of Commerce Building

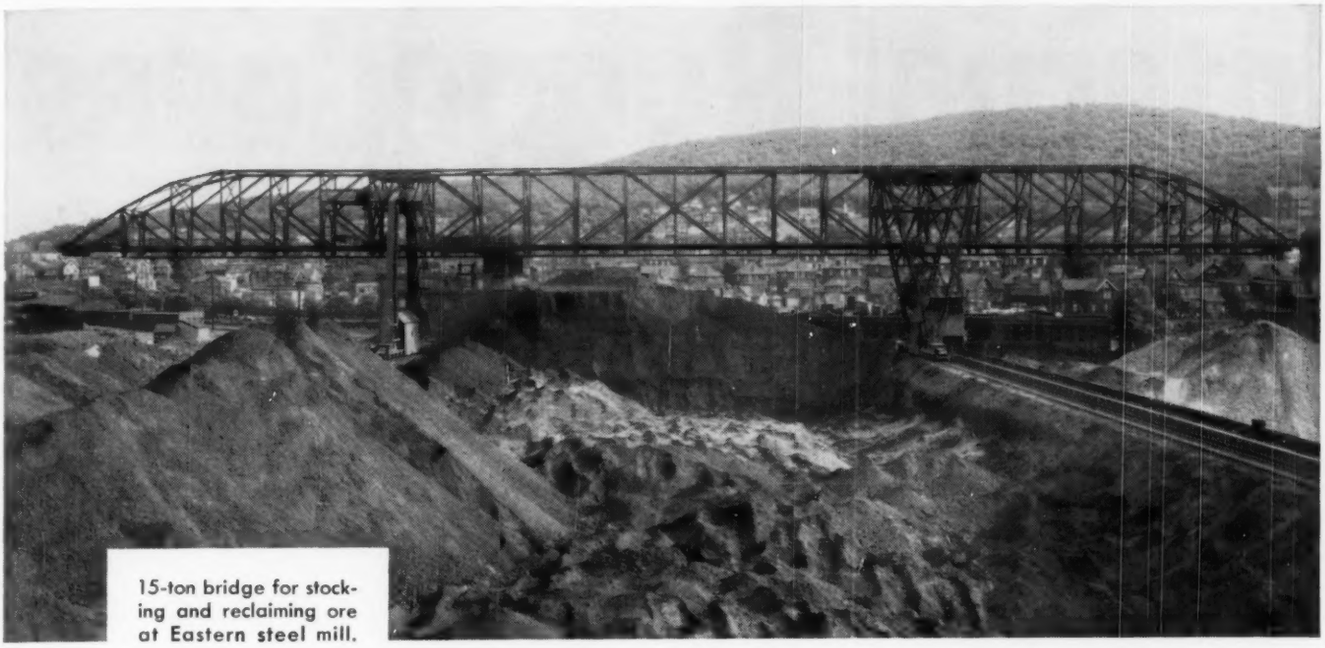
PROVIDENCE, R.I.
430 Hospital Trust Building

SYRACUSE, N.Y.
Salina and Genesee Streets

READING, PA.
First and Penn Avenues

CHARLOTTE, N.C.
1112 South Boulevard

In South America
Atlantic Refining Company of Brazil, Rio de Janeiro

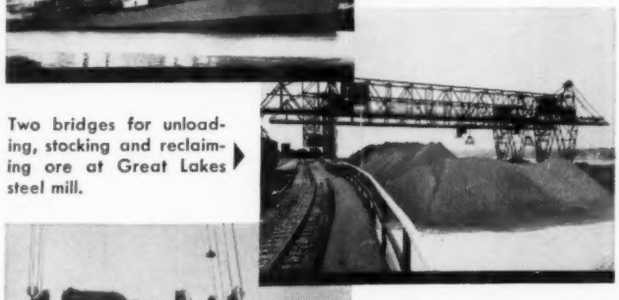


15-ton bridge for stocking and reclaiming ore at Eastern steel mill.

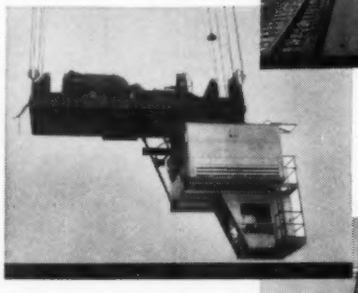
DRAVO heavy materials-handling equipment

. . . *custom built for you!*

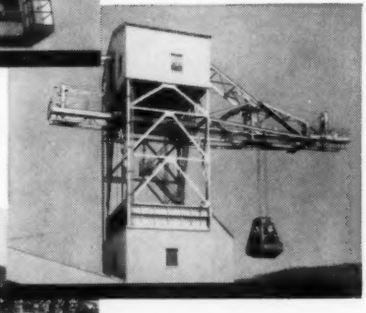
Traveling unloaders built to handle imported ore at an Atlantic port.



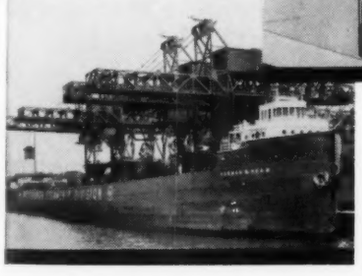
Two bridges for unloading, stocking and reclaiming ore at Great Lakes steel mill.



Light-weight man trolley installation increased bridge handling capacity 60%.



Coal unloader designed and built for a large mid-western electric power company.



Unloading ore boat at Lower Lakes port.

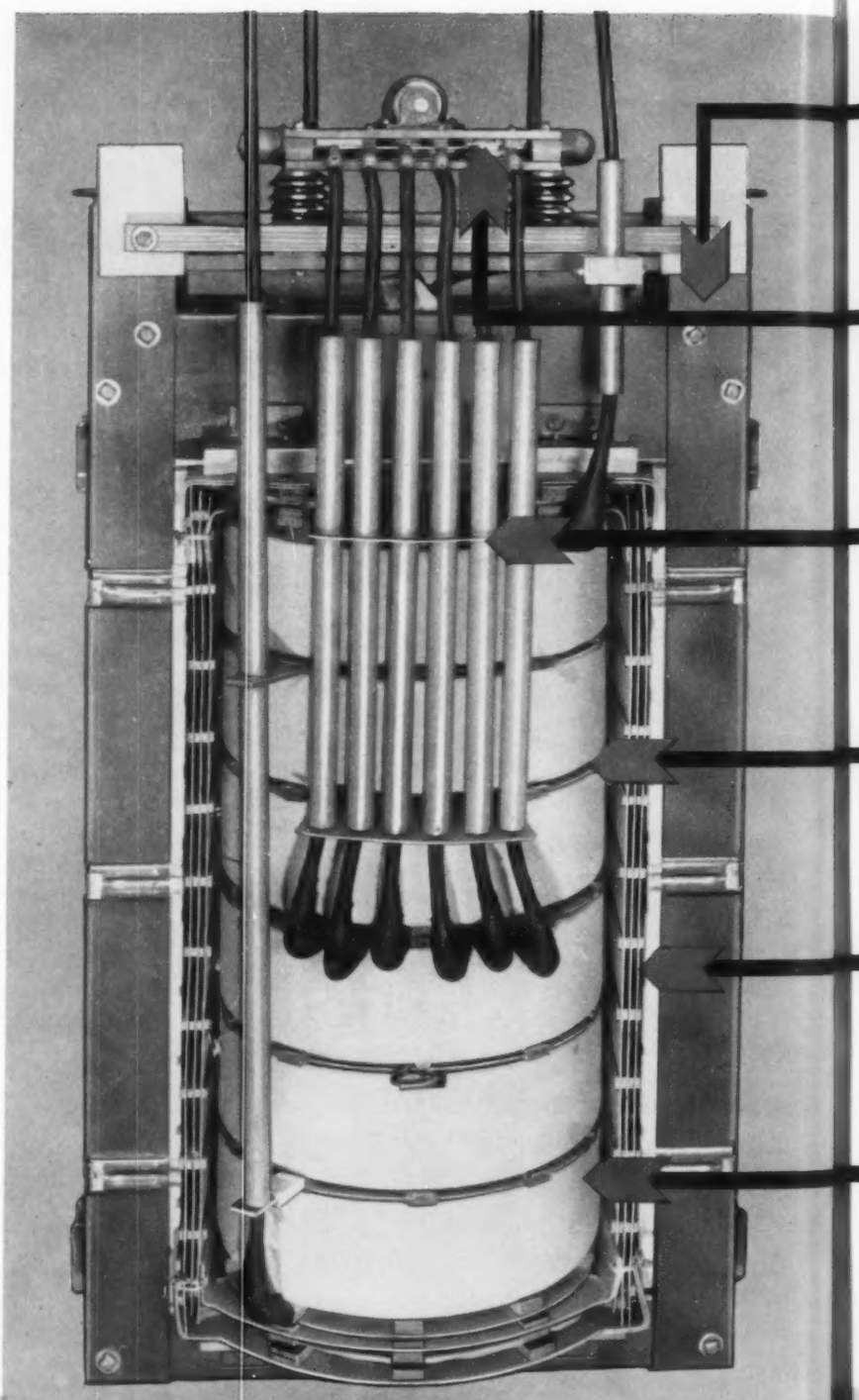
Over-all economy and safe performance are best obtained by using materials-handling equipment designed to suit your operating conditions. If you're planning a new materials-handling installation, we suggest an early "Round Table" session with Dravo engineers.

From actual experience in building and installing the type of equipment shown here, valuable know-how is available in working out features needed in your installation. This knowledge, along with your own operating experience, can be used to create a design incorporating all the best features for easy maintenance, a high safety factor, and simple, economical operation.

For complete information write DRAVO CORPORATION, NEVILLE ISLAND, PITTSBURGH 25, PENNSYLVANIA.

DRAVO
CORPORATION

Internal Ruggedness...



As a general rule, the higher the voltage, the more essential it is that transformer service be continuous and trouble-free. This is true from the standpoint of economics as well as that of customer satisfaction . . . and it is why Pennsylvania gives you *extra* ruggedness where it counts the most, in high voltage Pole Stars.

Take a look at the interior design features shown on these pages and see for yourself. From the patented lap-on-top core to little noticed lead supports, Pole Stars are designed and constructed to deliver *sustained performance* in every type of transformer installation. You can rely on Pole Stars for long range economy and dependability throughout the complete range of EEI-NEMA ratings: through 500 kva, through 67,000 volts, single phase. Pennsylvania Transformer Division, McGraw-Edison Co., Canonsburg, Pa.

The unit pictured is 500 kva. High voltage: 67,000 volts. Low voltage: 7560/13,090Y volts. Construction features shown may vary somewhat in other voltage classes.

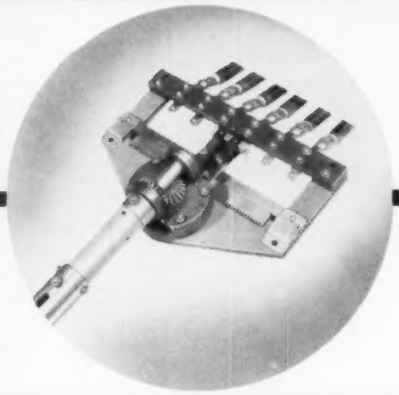
PENNSYLVANIA

S...

key to sustained performance of high voltage

POLE STARS

ANGLE-AND-CHANNEL CORE FRAME

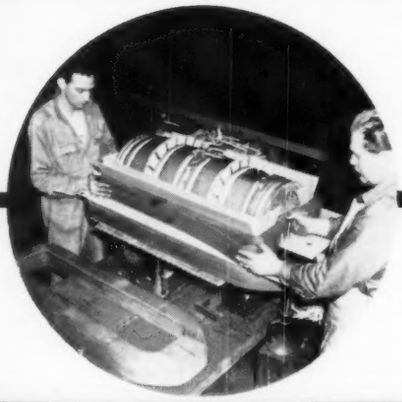


Core-and-coil assembly is supported by a sturdy, pressed steel, angle-and-channel frame, which is securely fastened together by bolts with permanently positioned nuts.

STRAIGHT-LINE TAP CHANGER

Straight-line tap changer is of same rugged design as that featured for years on Pennsylvania Power Transformers. Sintered silver-nickel contacts possess electrical qualities of silver and wearing characteristics of nickel.

INTEGRAL LEAD SUPPORTS

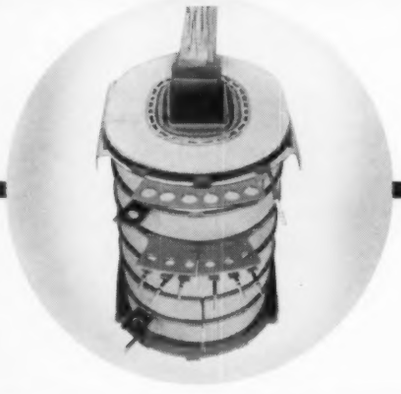


High voltage leads are insulated in pressboard tubing and held firmly in position by supports that are an integral part of the coil.

LAP-ON-TOP CORE

Core features Pennsylvania's patented lap-on-top construction. Laminations are individually lapped, creating a large cross-section area at lap that reduces density and prevents concentration of flux. Absence of gaps or butt joints assures low exciting current.

INSULATION AND BRACING



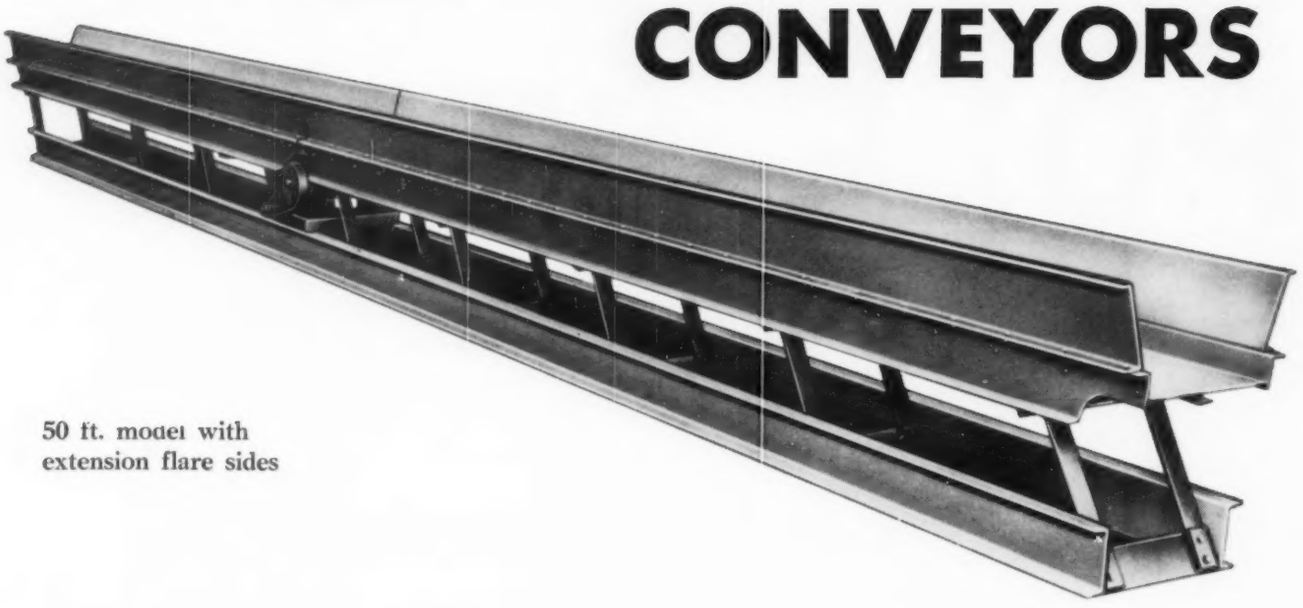
Coils are "packed out" with insulation to securely lock core and coil together. Maple braces provide extra support at top and bottom and help to protect against possible short circuit forces.

SECTIONAL COIL

High voltage windings are sectional, with low voltage layer windings inside. Use of sectional coils in higher voltages improves insulation . . . permits weight and size reductions. Also results in uniform distribution of impulse voltage and greater resistance to short circuit.

DISTRIBUTION TRANSFORMERS

SYNTRON SHAKER CONVEYORS



50 ft. model with extension flare sides

Handle dry or damp, hot, cold or corrosive materials efficiently at high rates

SYNTRON Shaker Conveyors are multi-purpose units designed for—high speed conveying of most bulk materials—pre-heating and drying bulk materials—for simultaneous scalping or sizing and conveying bulk materials when fitted with screen deck-utilizing the maximum width conveyor trough as picking table for manual removal of foreign objects from bulk materials.

SYNTRON Shaker Conveyors are rigidly constructed, engineered for long, dependable service with low operating and maintenance costs. They are motor driven units consisting of eccenter and rod operating each section.

SYNTRON Shaker Conveyors are available in lengths and widths to meet most operation requirements.

For recommendations send details of your operation to our materials handling engineering department.

Products of proven dependable Quality

Builders of Quality Equipment for more than one third of a century.

Other SYNTRON Equipment

designed to increase production, cut production costs, improve products

Vibrators (bins, hoppers, chutes)
Vibratory Feeders
Vibratory Screens
Shaker Conveyors
Vibratory Elevator Feeders
Weigh Feeders
Packers and Jolters
Hopper Feeders
Lapping Machines
Rectifiers (Silicon and Selenium)
a-c to d-c Selenium Rectifier Units
Electric Heating Panels
Electric Heating Elements
Sinuated Wires
Shaft Seals
Electric Hammers
Concrete Vibrators
Paper Joggers

Our representatives will be glad to work with you in selecting the proper equipment for your operation.

Call your nearest Syntron representative

RP558

Write for a SYNTRON illustrated catalog—FREE

SYNTRON COMPANY
699 Lexington Avenue Homer City, Penna.

Heavy Duty Ore Unloader Designed for 12-Ton Bucket.

Specially designed, fully equalized, short-coupled double-wheel Trucks permit "shoulder-to-shoulder" operation of the Unloaders so that Hatches as close as 38' centers can be emptied simultaneously.

2 More Good Reasons Why Ore Handling Brings To Mind

HEYL & PATTERSON

- ORE & COAL BRIDGES
- BOAT LOADERS & UNLOADERS
- COAL & COKE HANDLING EQUIPMENT
- RAILROAD CAR DUMPERS
  ROTARY, TURNOVER, HIGH-LIFT
- HYDRAULIC RAIL CLAMPS & BUFFERS
- PIG CASTING MACHINES
- SPECIALIZED CONVEYING SYSTEMS
- CAR HAULS & BOAT MOVERS
- COAL PREPARATION PLANTS
- BRADFORD BREAKERS
- THERMAL DRYERS
- WET CYCLONES

When Experience Counts—
Count On Heyl & Patterson!

The Heavy Duty Ore Unloader shown here is One of Two recently completed for an important eastern Steel Plant. Like all H & P Equipment, they are built for long years of dependable, Low-Cost Service.

Hydraulic Rail Clamps provide Automatic protection of the Unloader. Buffers at both ends of the trolley runway, as well as at the apron hingepoint secure the trolley against overtravel.

For your Special Unloading Requirements,
Consult an H & P Contracting Engineer.

Heyl & Patterson INC.

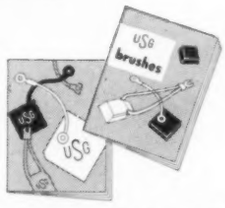
55 FORT PITT BLVD., PITTSBURGH 22, PA., COurt 1-0750

THIS USG® BRUSH REDUCES MAINTENANCE ON ALL MILL MOTORS

The brushes in steel mill motors and generators don't cost much, but they can make or break a production schedule. Run up maintenance costs, too. The economical USG Brush Grade 223 can reduce maintenance on motors because of its long-wearing qualities. The proven success of USG Brush Grade 223 is a result of fifty years' experience on all types of mill motors under all conceivable conditions.

But not only does the USG Brush 223 have a longer life . . . it has a permanent shunt connection found on all USG Brushes . . . called STATITE®. The shunt can't be jerked out and will not jar loose.

For low mill motor maintenance and longer brush life with minimum wear, specify the USG Brush Grade 223 with the permanent shunt connection, STATITE.



Copies of the latest USG Brush Catalog B-56 and the new USG Brush Grade Supplement are available on request.

B-254-1

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 9, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDERED METAL PARTS • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

a few of the many types of
SPRAYING SYSTEMS CO.

spray nozzles

. . . for such operations as roll cooling on hot and cold mills • descaling • runout table cooling • pickling line • cooling slabs on transfer table • cooling ingot molds • cooling open hearth tunnels or checkers • cooling pigs • coke chemical processing • spraying lubricants • and air and gas washing

For every spraying operation, you will find Spraying Systems spray nozzles offer impressive, measurable advantages. That is why so many mills today specify Spraying Systems spray nozzles for every application. Made in a very wide range of types and sizes to provide exact performance to meet your requirements. To improve operations where spraying is involved, try Spraying Systems spray nozzles . . . . the engineered products of America's leading designer and manufacturer of spray nozzles for industry. Your inquiry is cordially invited.

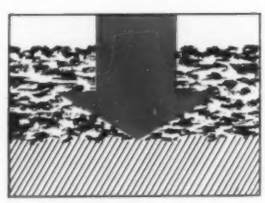
SPRAYING SYSTEMS CO.
3262 RANDOLPH STREET • BELLWOOD, ILLINOIS

Write for your FREE copy of new Catalog No. 24 . . . the most comprehensive spray nozzle catalog ever produced.

Helping to make present equipment last longer

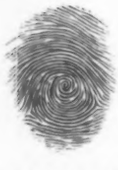
Apply Rust-Oleum 769 Damp-Proof Red Primer directly over sound rusted surface! Specially-processed fish oil vehicle penetrates rust to bare metal!

Cut costly surface preparations and save time, money, and metal by applying Rust-Oleum 769 Damp-Proof Red Primer over sound rusted surfaces after simple scraping and wirebrushing to remove rust scale and loose rust. You can do this because Rust-Oleum's *specially-processed* fish oil vehicle penetrates through the rust to bare metal, driving out air and moisture that cause rust. At the same time, it dries to a tough, durable surface coating that resists general weathering up to one year before applying the Rust-Oleum finish coat. See how Rust-Oleum can save you time, money, and metal. What Rust-Oleum has saved for others is not half so important as what it can do for you.



Write for special thirty-page report showing Rust-Oleum penetration through rust to bare metal as prepared by Battelle Memorial Institute Technologists.

RUST-OLEUM®

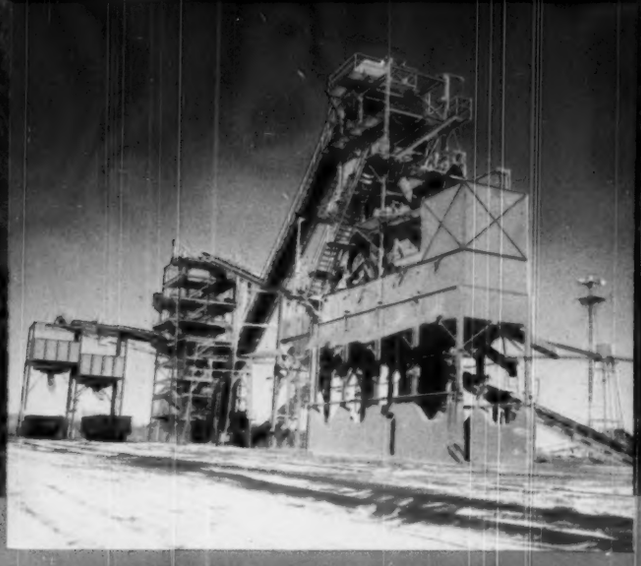


Distinctive as your own fingerprint.
Accept no substitute.

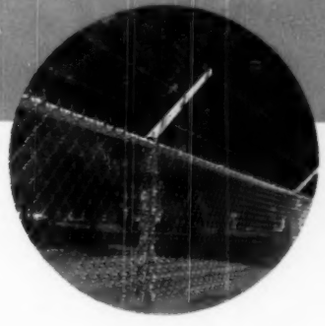
STOPS RUST!®

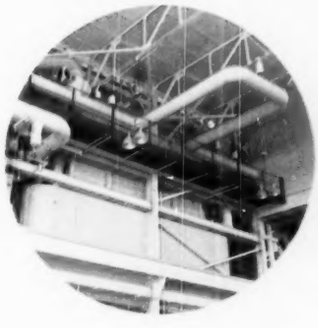
Prompt delivery
from Rust-Oleum
Industrial Distributor stocks.

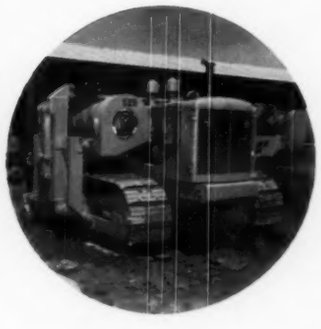
US! ...d beautifies as it protects!



Applying Rust-Oleum Aluminum finish coating over the Rust-Oleum primer for lasting beauty.







Follow-up with the Rust-Oleum finish color of your choice for double protection and lasting beauty!

Stop Rust!—and do it in the color of your choice—that's step number two in the Rust-Oleum rust-prevention *system*. Simply apply the Rust-Oleum finish color over the 769 Damp-Proof Red Primer. You receive *double protection* and greater compatibility, because Rust-Oleum finish colors utilize the *specially-processed* fish oil vehicle—and they dry to a firm, decorative, high-gloss finish that resists sun, fumes, heat, moisture, weathering, salt air, etc. You *beautify as you protect*, because Rust-Oleum finish coatings are available in Aluminum, Black, Green, Yellow, Gray, Blue, White, Red and many others. Write for complete information with color charts. Specify Rust-Oleum for new construction, maintenance, and re-modeling. Rust-Oleum Industrial Distributors maintain complete stocks for your convenience . . . and will be happy to consult with you on your rust problems.

What is your rust problem? What Rust-Oleum color do you need?

White, Black, Aluminum, Gray, Green, Blue, Yellow, Red and many others—they're all yours with Rust-Oleum! Beauty that lasts over-the-years. Rust-Oleum is also available in custom formulations to match unusual colors or to meet unusual rust-producing conditions. Send us your rust problems. We'll send you complete details—no charge or obligation.

ATTACH TO YOUR LETTERHEAD FOR THE FACTS

Rust-Oleum Corporation
2990 Oakton Street • Evanston, Illinois

Please send me the following.

- ☐ Complete literature with applications and color charts.
- ☐ Information on matching special colors.
- ☐ Thirty-page report on Rust-Oleum penetration.

HOW TO CONTROL ATMOSPHERES...

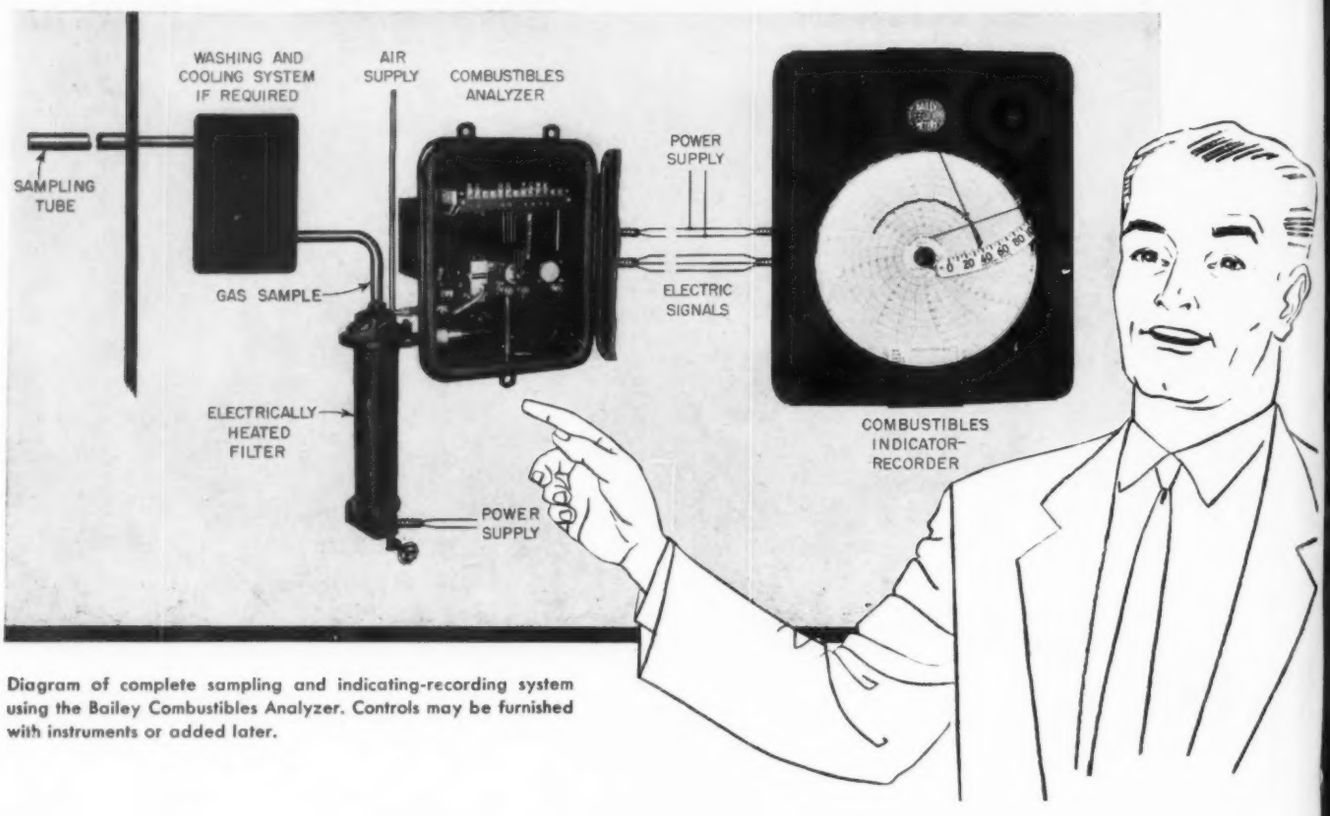


Diagram of complete sampling and indicating-recording system using the Bailey Combustibles Analyzer. Controls may be furnished with instruments or added later.

BAILEY COMBUSTIBLES ANALYZER

improves steel quality, saves gas

Whether you are doing bright annealing, hardening, normalizing or carburizing, keeping a constant watch on your atmospheres with a Bailey Combustibles Analyzer will help you do a better job at lower cost. This instrument provides a continuous measurement of the per cent combustible in the protective atmosphere gasses. It operates a remote electronic receiver for indicating, recording and controlling.

The Bailey Combustibles Analyzer monitors the quality of atmosphere gas. When the quality changes, as shown by changes in the per cent combustibles, the Analyzer operates a pneumatic controller which automatically controls the fuel rate. By maintaining the proper gas-air mixture, the uniformity of the atmosphere—and of the final steel product—is protected.

An important use for the Bailey Analyzer is in furnace purging—necessary to prevent explosion during startup. The instrument tells the operator when the combustibles have been reduced to a point where it is safe to start up the furnace. Without a Bailey Analyzer, purging is usually done strictly on a time basis, a procedure that is wasteful and unsafe.

Put the Bailey Combustibles Analyzer to work as a watchdog and control on your atmosphere generators and heat treating furnaces. It is the one way you can be sure you are maintaining the atmospheres specified by metallurgists for your processes.

Your Bailey Engineer will show you how you can use this instrument to improve steel quality and save gas. Or, write to our Iron & Steel Division for Product Specification E65-3 with complete details. S8-1

BAILEY METER COMPANY

IRON AND STEEL DIV., 1047 IVANHOE ROAD, CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

INSTRUMENTS AND CONTROLS FOR POWER AND PROCESS

BAILEY BUILDING BLOCK METHOD

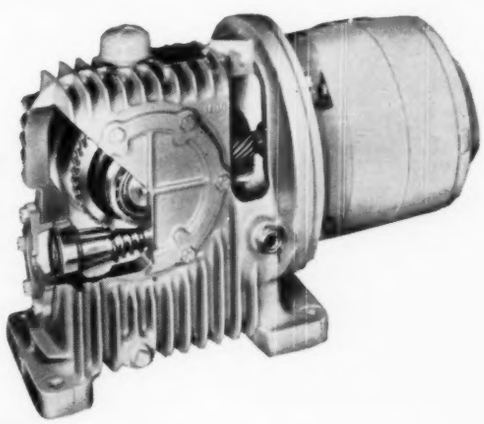
Here's a whole new family of fine GEARMOTORS by Cone-Drive Gears

MOUNT THEM ANYWHERE—FLOOR, WALL, CEILING, OR HANG THEM ON A SHAFT...

. . . there's a Cone-Drive gearmotor for every need. Look at the extensive line of space-saving, power-packed models now available. No matter whether you're faced with floor, wall, ceiling, or shaft mounting at any angle, Cone-Drive Gears has a gearmotor for the job.

It's the most versatile line available PLUS big power capacity in a really compact package. Double-enveloping worm gears, pioneered and proven by Cone-Drive Gears, are combined with a helical primary and extra-large taper roller bearings in a rugged finned housing to give you a power package without equal. You can select any model in any of 27 standard output speeds (7.3 to 525 rpm at 1750 rpm input) in capacities from 1 through 25 horsepower.

Best of all, Cone-Drive gearmotors are priced right down with units that can't deliver nearly as much performance and versatility. Check your nearby Cone-Drive representative or write today for new Catalog 57 containing complete specifications.



Cutaway view of typical Cone-Drive gearmotor illustrates use of double-reduction gear train for increased output power. Note also large taper roller bearings and heavy-ribbed housing.

CONE-DRIVE GEARS

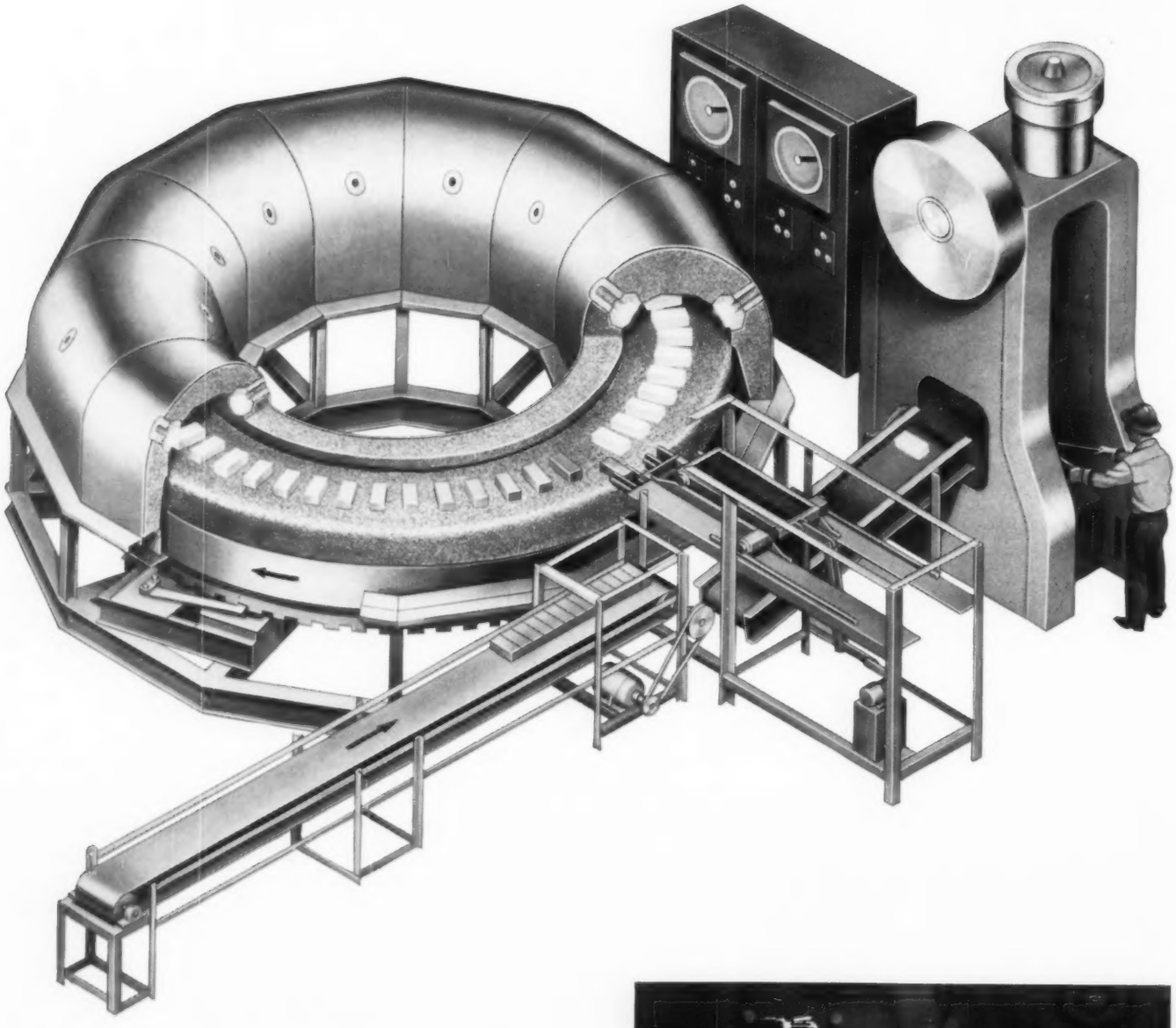
Division Michigan Tool Company

DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS

7171 E. McNichols Road • Detroit 12, Michigan

our research is your reward

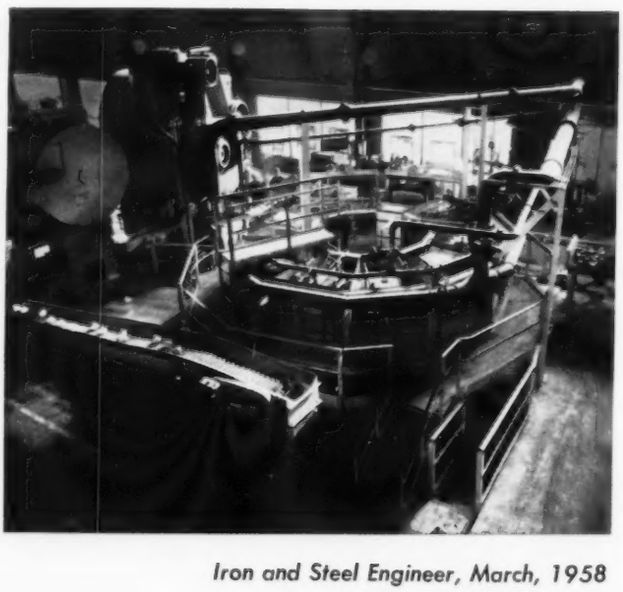
SELAS Gradiation® provides



Billets from 3½ in. to 4¼ in. square cross-section and from 3.4 in. to 10.8 in. in length are rapidly heated in this Selas rotary-hearth furnace to 2200°F at rates up to 11,000 lb per hr. Billets weigh up to 55 lb each.

The entire operation . . . charge, discharge, transfer and press loading . . . is automated. (Manual handling is used for longer billets weighing up to 170 lb each.) All equipment shown above, except press, was supplied by Selas. Many types of steel are heated including AISI 1030, 4620, 2815 and 8720.

In the lower picture, showing actual installation in the job-forging department of a large eastern steel mill, the furnace, press, trimmer and delivery conveyor form a compact processing unit. Overall diameter of the furnace proper is only 21 ft. Shipped from Selas assembled in sections, this custom-built rotary furnace was installed in the customer's plant with minimum interference to production operations.



Fast, Uniform Heating

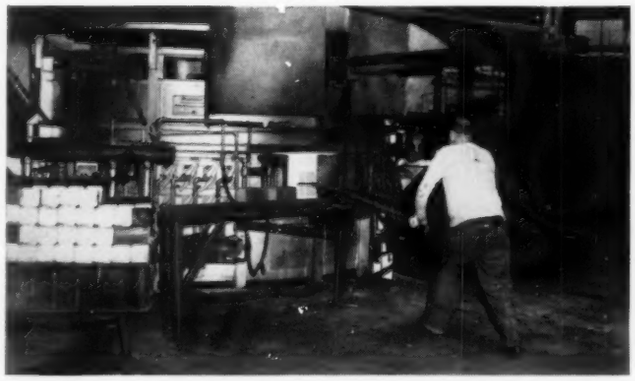
improves forgeability
reduces forging costs
minimizes scale

Improved forgeability, directly attributable to fast heating, reduces power requirements at the usual forging temperatures. Or, for given power applied, the amount of flow or deformation is increased. This increased capacity for hot work can be used to advantage to permit forging at lower temperatures, with no increase in applied work.

The ability to forge at lower temperatures is of practical significance in that one or more reheats can be eliminated, since the workpiece stays longer at forging temperature.

The fast heatup of the workpiece attained with Gradiation heating virtually eliminates scale . . . **permitting more accurate forging and cleaner surface** . . . cuts metal loss, **making possible a reduction in starting billet weight.** Descaling is rarely necessary.

All of these features of Selas Gradiation heating contribute to reduced forging costs. Another measure of cost reduction lies in the space-saving features of Selas furnaces. The characteristic compactness of this high-capacity equipment . . . whereby the heat is directed into the workpiece rather than the work area . . . is often translated into a 75% reduction in floor space requirements. Whether your preference is for AUTOMATIC, SEMI-AUTOMATIC or MANUAL HANDLING, Selas engineers will be glad to discuss with you how these benefits of Selas Gradiation can be applied to your forging operations. Address Selas Corporation of America, Dept. 43, for technical information.



Steel billets up to 7 in. square are heated at production rates up to 8,000 lb per hr—with manual handling—in this Selas Gradiation furnace at Lansdowne Steel and Iron Company. Fast heating to 1850°F, at rates of 2 to 5 min per in. of thickness, virtually eliminates scale, making possible a 10% reduction in original billet weight. Fast-heated billets are forged at temperatures 300°F below that of conventional methods.

Complete automation is achieved by integrating Selas Gradiation heating into Chambersburg Engineering Company's Cecomatic forging process. Brass slugs, up to 1-1/6 in. dia x 3¼ in. long, are heated to 1500°F and delivered automatically to the Impactor at production rates which can be varied from 20 to 40 forgings per min.

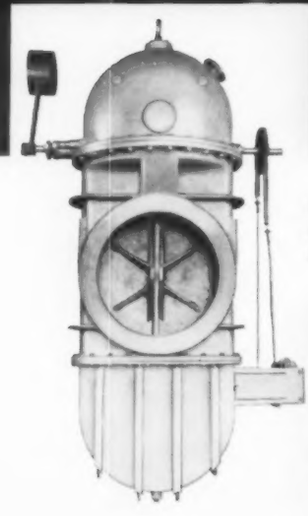
Gradiation is a registered trade name of Selas Corporation of America

SELAS
CORPORATION OF AMERICA
DRESHER, PENNSYLVANIA

Heat and Fluid Processing Engineers

DEVELOPMENT • DESIGN • CONSTRUCTION

Freyn-Jansen Stove Valve



Freyn-Jansen Stove Valve reduces stove changing time, prevents gas leakage at the burner.

For over 25 years this stove valve has satisfied blast furnace operators in many countries. Here's why:

. . . reduces stove changing time

It replaces the conventional stove door providing quick, effortless action that saves time and work in opening and closing the burner inlet to the stove, regardless of burner opening size. A counterweighted valve operating shaft permits fast, easy operation either by manual lever, motor actuator or compressed air.

. . . prevents gas leakage

Permanently installed with bolted flanges between the burner discharge and the stove inlet, the Freyn-Jansen Valve prevents any gas leakage.

. . . provides tight, sure closure

It's designed so that cold blast pressure forces the valve against the seat, not away from it. In fact, the higher the pressure, the tighter the valve seats—makes it impossible for the disc to be blown off the stove.

. . . reduces maintenance

The conventional stove door requires maintenance of its refractory lining and gasket between the door and stove. Neither refractory lining nor gasket at the valve seat is used on the Freyn-Jansen Valve.

Send for descriptive information that gives you all the facts, or consult our engineers.

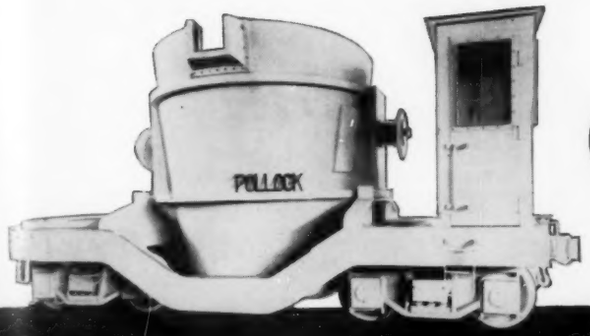
KOPPERS COMPANY, INC.
ENGINEERING AND CONSTRUCTION DIVISION
Pittsburgh 19, Pa.

KOPPERS®

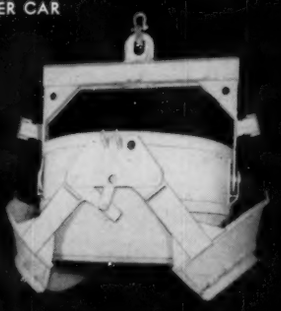
FREYN DEPARTMENT
ENGINEERING AND CONSTRUCTION DIVISION

POLLOCK

Open hearth handling equipment

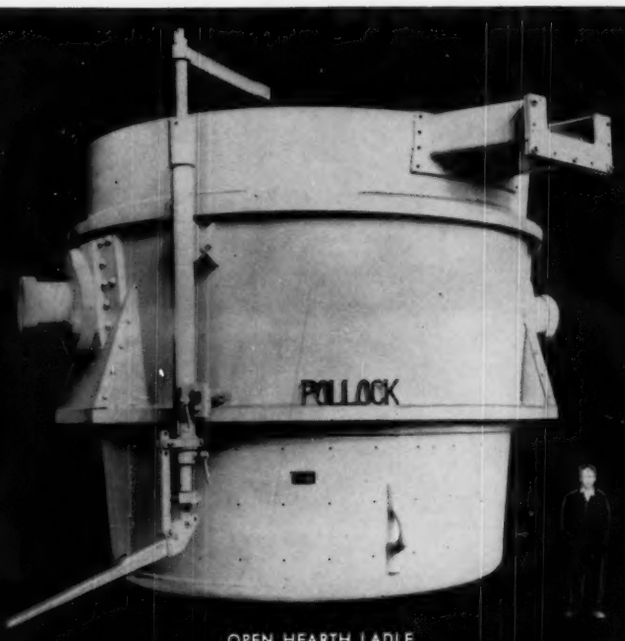


HOT METAL TRANSFER CAR

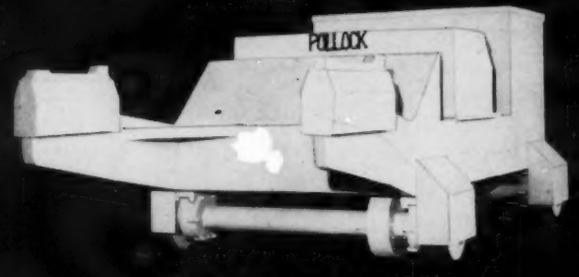


ELECTRIC FURNACE CHARGING BUCKET

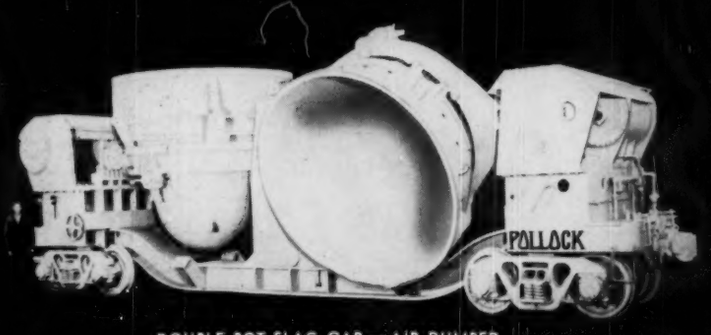
INGOT CAR



OPEN HEARTH LADLE



FRONT-FLUSH SLAG CAR



DOUBLE POT SLAG CAR — AIR DUMPED

an Important factor in increased production

Efficient handling of molten and heavy materials within open hearth plants requires equipment with three characteristics—safety, strength and durability. Pollock equipment meets these necessities. The William B. Pollock Company, in 94 years of operation, has also built more blast furnace handling equipment than any other firm.

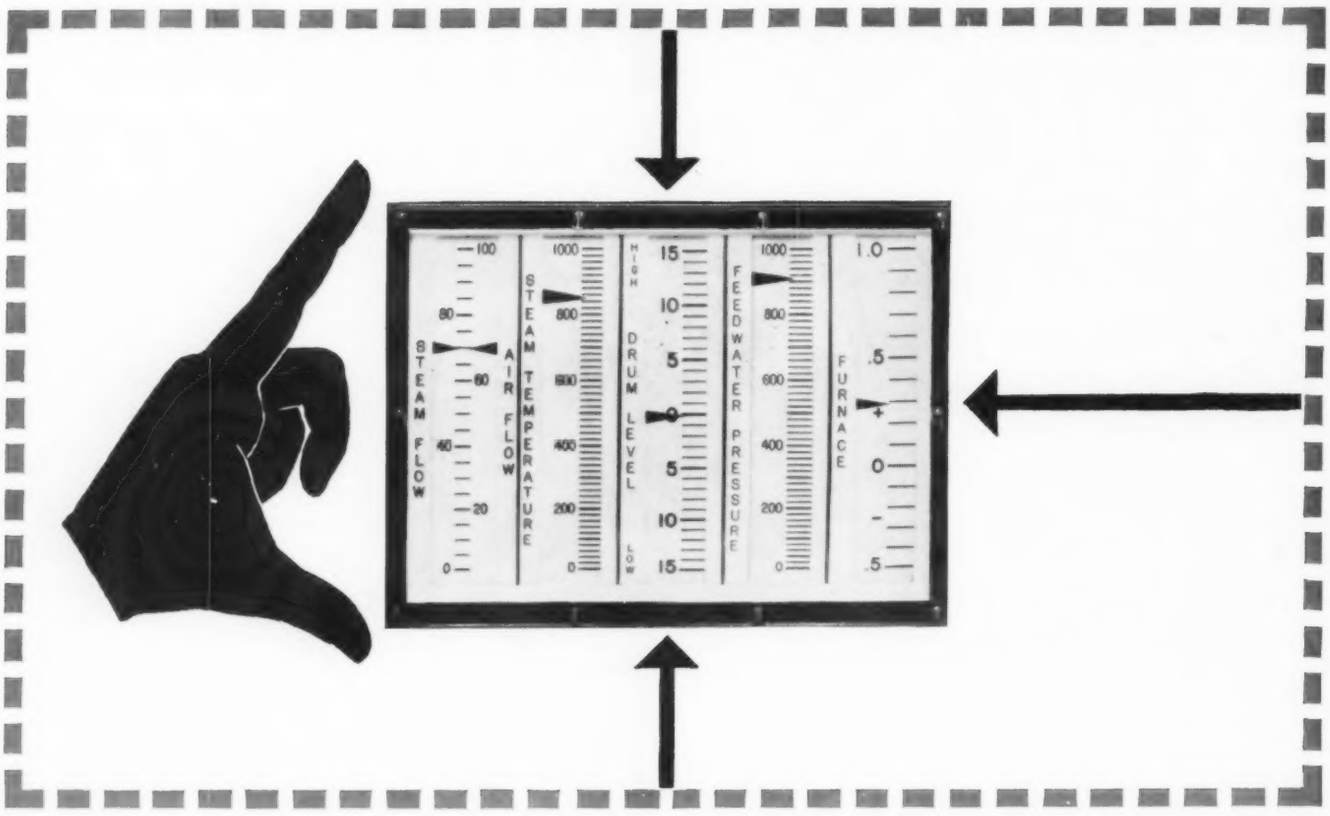
When you plan a new open hearth, remodel an existing open hearth or re-equip an open hearth, take advantage of the experience available to you at Pollock. General specifications are available on request. Special-performance details will be engineered to your specifications. Pollock engineers will work closely with your engineers to give you the equipment that meets your needs best.

POLLOCK
SINCE 1863

THE WILLIAM B. POLLOCK COMPANY
YOUNGSTOWN, OHIO

STEEL PLATE CONSTRUCTION • ENGINEERS • FABRICATORS • ERECTORS

BLAST FURNACES • HOT METAL CARS AND LADLES • CINDER AND SLAG CARS • INGOT MOULD CARS • CHARGING BOX CARS • WELDED OPEN HEARTH LADLES



Get big-gauge accuracy and sensitivity with

Republic's V5 Series of Compact Measuring Instruments

Two sets of Republic V5 gauges mounted on a modern console-type boiler control panel. Gauges match the compactness of the other instruments, yet are easy to read—even from a distance.

Republic V5 gauges feature full-sized diaphragms, bellows and helixes, yet require only one-fourth as much panel space as ordinary instruments. *Eight* V5 gauges can be mounted in a single bank requiring only about 14″ x 6½″. This compactness makes them ideal for console or graphic type panels. Each V5 gauge is an independent unit, which may be removed or replaced without disturbing adjacent gauges. Each 5″ vertical scale is illuminated from the rear for top readability—even from a distance.

A full line of V5 gauges is available for measuring draft, pressure, differential gas pressure and temperature, and for use as receivers with pneumatic transmitters for indicating flow, liquid level, density, high pressures and other process variables. If you would like to save panel space—without sacrificing instrument readability, performance and flexibility—a talk with your Republic engineer could be time well-invested. A card or a call will bring him. Republic sales offices are located in principal cities throughout the United States and Canada. Detailed information in Bulletin No. 806 . . . your copy is waiting.

A FEW OF THE OPTIONS AVAILABLE:

- Duplex bellows or helix gauges with two pointers operating on the same scale; occupies same space in group as a single-gauge unit.
- Set point indicator available on single bellows and helix units.
- Compound and reversed scales available.
- Reverse acting pointer motion available. (Can be reversed in the field without any change in parts.)
- High and low alarm contacts can be provided with all types of units.

REPUBLIC FLOW METERS CO.

Subsidiary of ROCKWELL MANUFACTURING COMPANY
2240 DIVERSEY PARKWAY CHICAGO 47, ILLINOIS
In Canada: Republic Flow Meters Canada, Ltd.—Toronto
Manufacturers of electronic and pneumatic instrument and control systems for utility, process and industrial applications.

BEARINGS OF ALCOA ALUMINUM OUTPERFORM ALL OTHER SOLID-WALL BEARINGS...

Only aluminum has the combination of advantages demanded for the best all-around performance of solid-wall bearings. Alcoa® Aluminum alloys have the unmatched combination of these advantages to give you bearings that:

Withstand heaviest loads . . . Solid aluminum bearings withstand loads up to 10,000 psi on projected area.

Run cooler . . . Aluminum is the best heat conductor among bearing materials, and this means cooler running bearings . . . as much as 20° cooler by actual test.

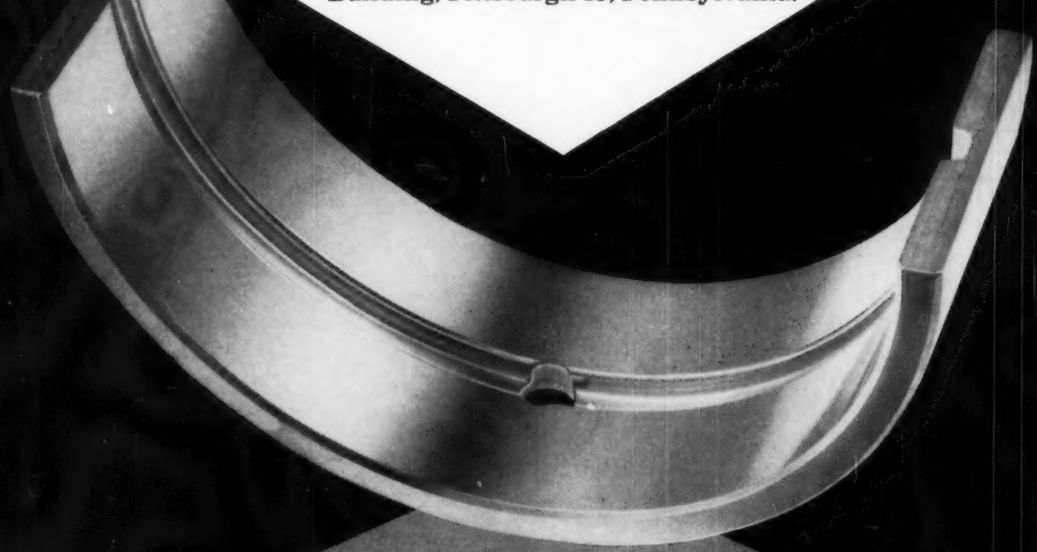
Conform readily . . . Aluminum has good ductility, conforms readily to misaligned shafts or nonparallel pins and thus reduces unit loading for longer bearing life.

Have ideal embeddability . . . Aluminum embeds particles far better than bronze, but not as deeply as babbitt. Dirt particles roll out easily and are trapped by the filter.

Resist corrosion . . . Aluminum bearings do not corrode . . . are unaffected by additives in oils, need no protective coating.

Have design flexibility . . . The structural properties of aluminum give great design flexibility, ease of machinability.

Why not investigate the use of solid aluminum alloy bearings for your equipment? Call your nearest Alcoa sales office or write to Aluminum Company of America, 1983-C Alcoa Building, Pittsburgh 19, Pennsylvania.



ALCOA ALUMINUM BEARINGS

ALUMINUM COMPANY OF AMERICA

Your Guide to the Best in Aluminum Value

"ALCOA THEATRE"
Exciting Adventure,
Alternate Monday Evenings

* Sintering Plant at a Major Steel Company...

Four years without fan replacement since installing

WESTERN PRECIPITATION CMP EQUIPMENT!

The steel industry's sintering plants have a double-barreled reason for installing the most efficient equipment available for dust recovery . . . (1) elimination of air pollution, and (2) reduction of fan wear. And the best indicator of collector efficiency is to watch for fan wear, because *negligible fan wear means negligible dust, minimum air pollution!*

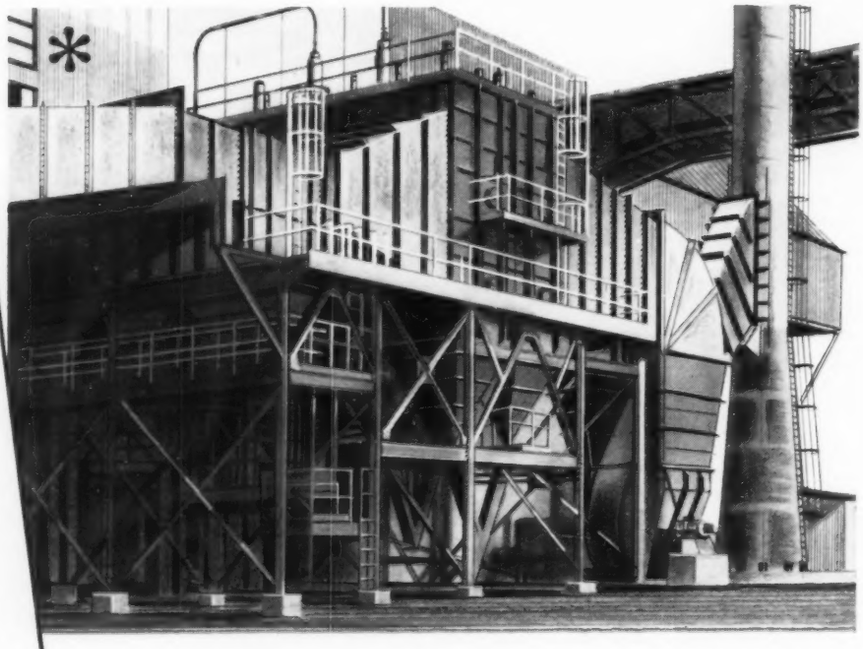
The experience of one major eastern steel company is particularly significant. Since installing Western Precipitation CMP Units four years ago, it has not been necessary to replace or repair a single fan in the plant systems these units serve.

Moreover, this CMP equipment has proven so satisfactory that this same company has ordered and reordered additional installations. *To date, six CMP installations are either already in service or are on order for this one plant!*

The CMP is another product pioneered by the industry's most experienced organization in dust, fume and fly ash recovery—Western Precipitation Corporation. Backed by Western Precipitation's years of know-how in both *electrical* (Cottrell) and *mechanical* (Multiclone) recovery principles, the CMP (Combination Multiclone - Precipitator) combines advantages of *both* these basic types into *one* compact coordinated unit. The Multiclone section mechanically separates all but the very finest suspended particles, and then the Cottrell section provides final clean-up with electrical ionization.

Result:

Unusually high recovery efficiency at low installation and maintenance costs. Best of all, there is no "transfer wear" from sintering plant fans to recovery equipment, for CMP maintenance requirements are negligible.



No matter what your recovery requirement, the know-how of the industry's most experienced organization in dust, fume and fly ash recovery is at your service. We are equipped to handle installations on either a complete "turnkey" basis, or supply equipment only, whether electrical (Cottrell), mechanical (Multiclone), filter (Dualaire)—or combination systems.

Throughout the major industrial areas of United States and Canada, there's a Western Precipitation office as near as your telephone. May we place this unequalled know-how at your service?

COTTRELL Electrical Precipitators
MULTICLONE Mechanical Collectors
CMP Combination Units
DUALAIRE Jet-Cleaned Filters
HOLO-FLITE Processors
HI-TURBIANT Heaters

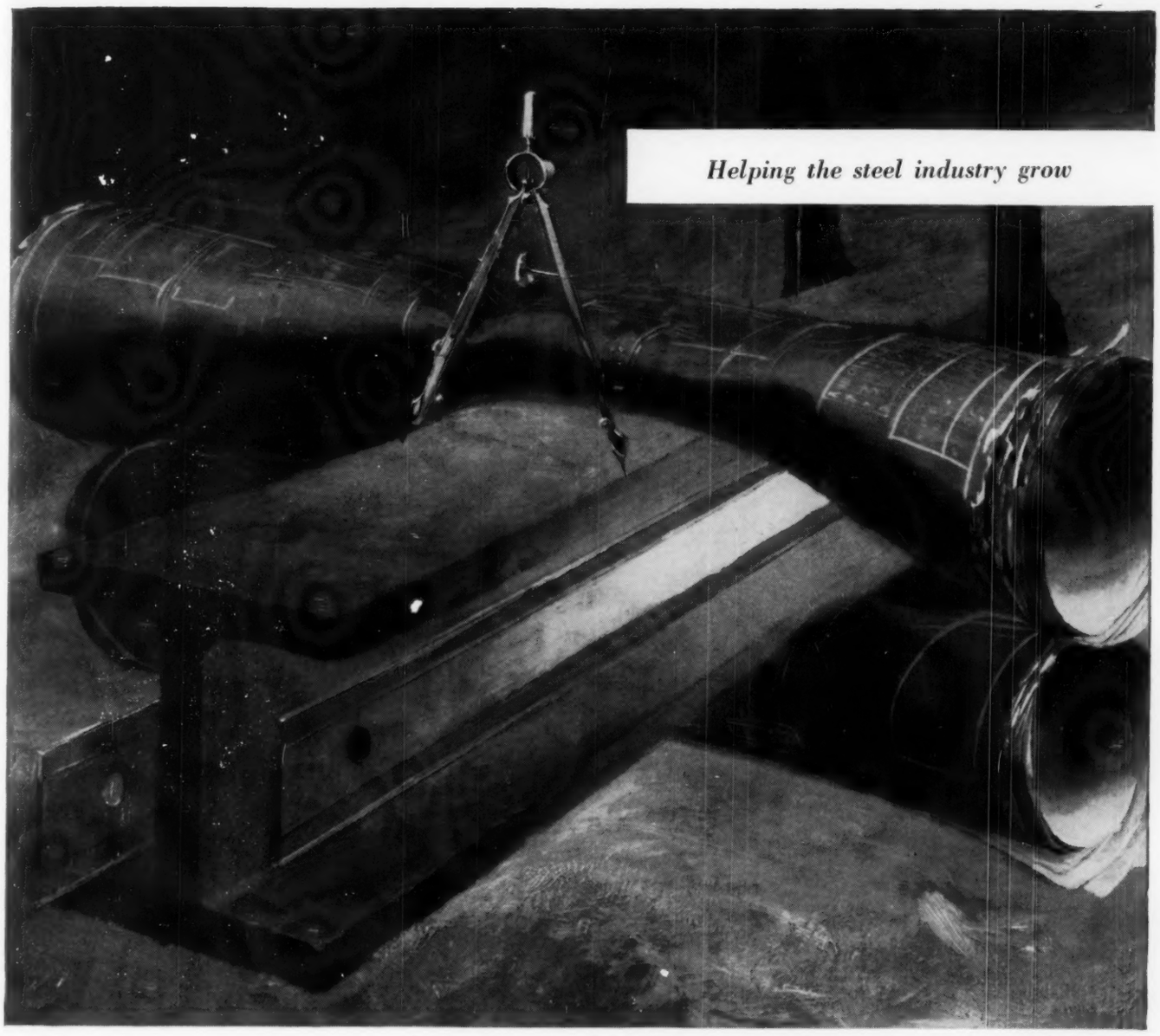
WESTERN
PRECIPITATION
CORPORATION

Engineers and Constructors of Equipment for Collection of Suspended Material from Gases and Equipment for the Process Industries

LOS ANGELES 54 • NEW YORK 17 • CHICAGO 2 • PITTSBURGH 22 • ATLANTA 5 • SAN FRANCISCO 4

Representatives in all principal cities

Precipitation Company of Canada Ltd., Dominion Square Bldg., Montreal



Steel is basic, and the steel industry is constantly increasing its capacity to supply America's dynamic economy. Here the art of Stanley Meltzoff symbolizes the engineering experience and production skills which keep the nation well ahead in output of this vital metal.

Constructing in Five Dimensions

Many projects must be executed not only in the conventional three dimensions, but also within the inflexible limits of time and budget. Our skilled and experienced team has proved many times its ability to complete a project on schedule and at a cost both reasonable and controlled. The range of our services is broad and flexible; facilities can be adapted precisely to moderate or extensive needs.

We have served many of the country's leading steel producers, designing and installing such facilities as rolling mills, slab heating furnaces, sintering strands, desulfurizer stations, oxygen plants, power plants, and coal handling equipment.

Our many new assignments from clients previously served speak for the caliber of our past performance. Our more than 70 years' experience assures you of maximum return on each dollar expended. We invite you to share and profit from this background.

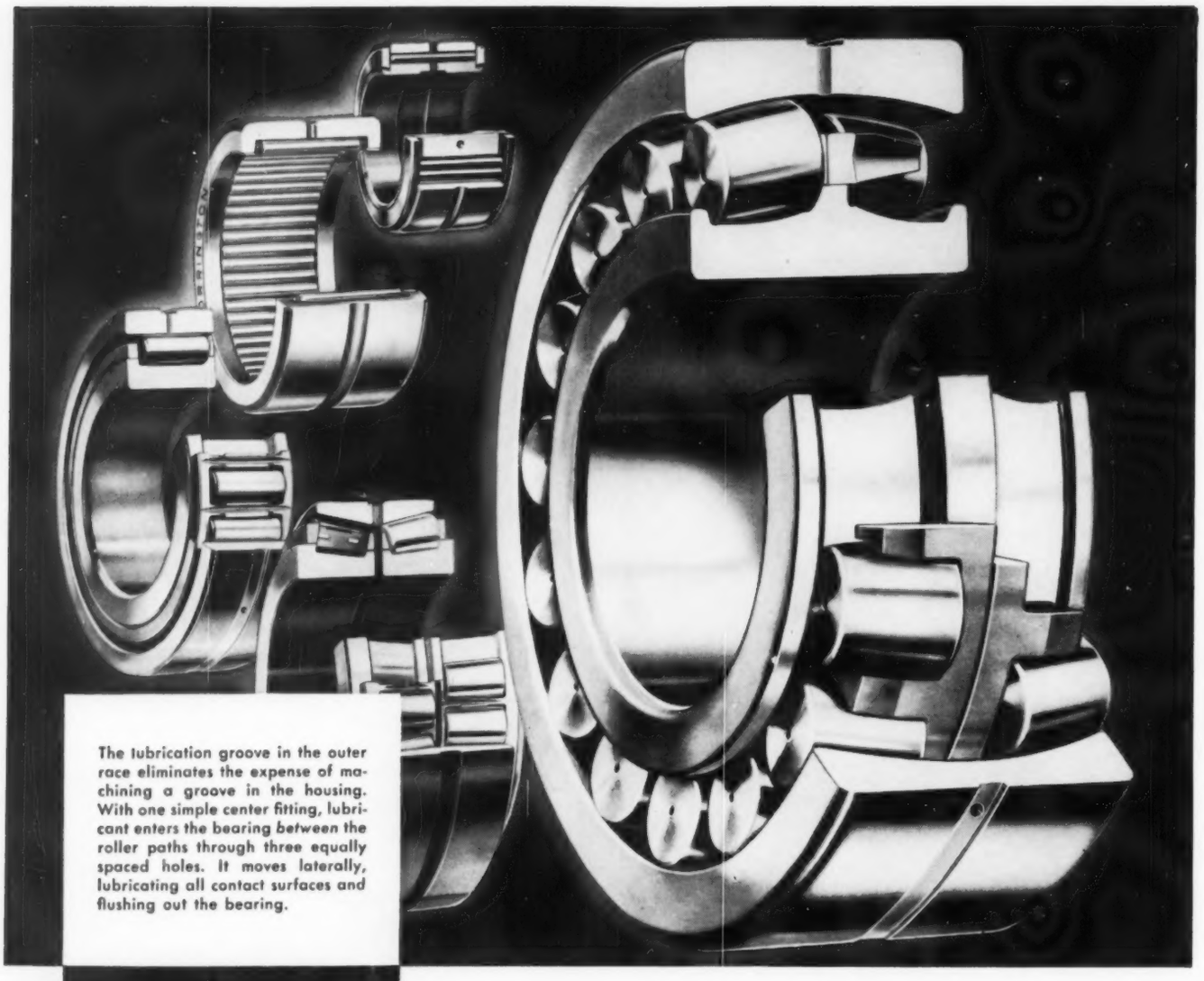
UNITED ENGINEERS

& Constructors Inc

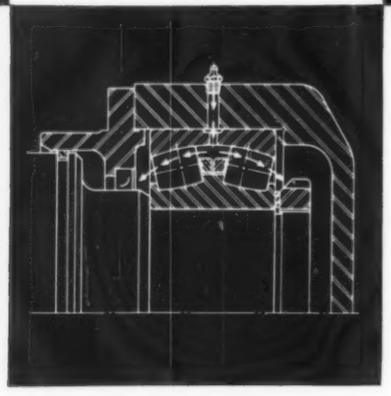
U.E.&C. (Canada) Ltd.

Designers • Constructors • Consulting Engineers

New York • PHILADELPHIA • Chicago



The lubrication groove in the outer race eliminates the expense of machining a groove in the housing. With one simple center fitting, lubricant enters the bearing *between* the roller paths through three equally spaced holes. It moves laterally, lubricating all contact surfaces and flushing out the bearing.



A time-proved lubricating method now available on Torrington Spherical Roller Bearings

The circumferential groove in the outer race has met the test of experience in many Torrington Bearings, including Heavy Duty Needle Bearings, Aircraft Type Needle Bearings, Tapered and Radial Roller Bearings. Now the circumferential lubrication groove is available in Torrington Spherical Roller Bearings.

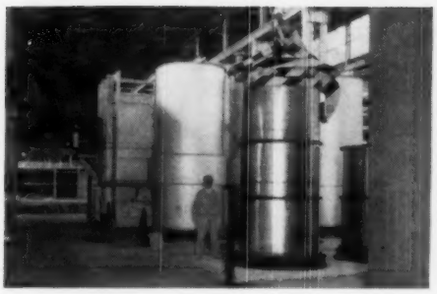
This design feature makes it possible to introduce lubricant *between* the roller paths without the expense of machining a groove in the housing. This groove is proportioned to provide generous lubricant flow capacity. Lubricant moves through the roller paths, flushing used lubricant and contaminants away from bearing contact surfaces.

Torrington Spherical Roller Bearings in many sizes may be ordered with this groove as desired at no additional cost. For further information, see your Torrington representative or write: **The Torrington Company, South Bend 21, Ind.—and Torrington, Conn.**

TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

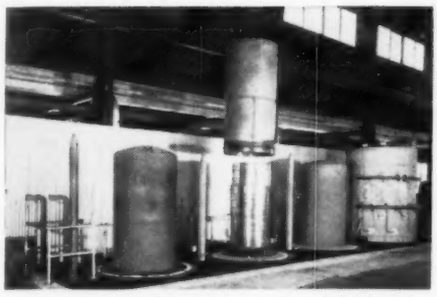
SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • NEEDLE • BALL • NEEDLE ROLLERS • THRUST



Part of an installation of large gas fired three-stack rectangular bell type forced circulation special atmosphere furnaces for annealing strip.

Bell Type FURNACES

Built to Suit Your Plant, Product or Process



Built right—over 20 years ago—this EF installation is still in operation, daily—and producing first class work.

Single or multi-stack — circular, rectangular or square types — upright, elevator or partial pits — gas fired, oil fired or electric — correctly designed, built and installed, ready to produce.

Backed by over 40 years of practical furnace building experience, EF furnaces incorporate all the advantages of all bell type designs, for processing strip, wire, rod and other ferrous and non-ferrous products.

EF bell type furnaces installed over 20 years ago are still in service daily, producing first class work. After all, there's no substitute for experience. At your convenience EF experienced engineers will be pleased to discuss the best type for your specific requirements.

EF direct gas fired forced circulation bell type furnace for processing wire, rod, strip and other products. The split cover design permits installing where head room is limited.

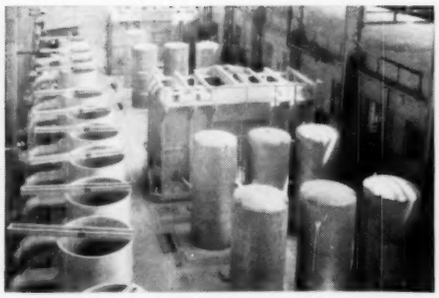
THE ELECTRIC FURNACE CO.

GAS FIRED, OIL FIRED AND ELECTRIC FURNACES FOR ANY PROCESS, PRODUCT OR PRODUCTION

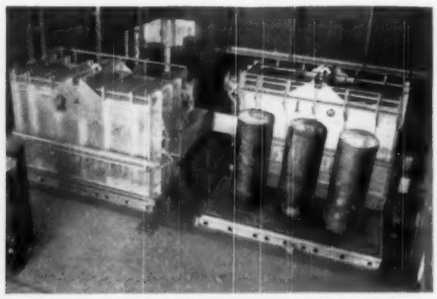
Salem - Ohio

Canadian Associates • Canefco Limited • Toronto 1, Canada

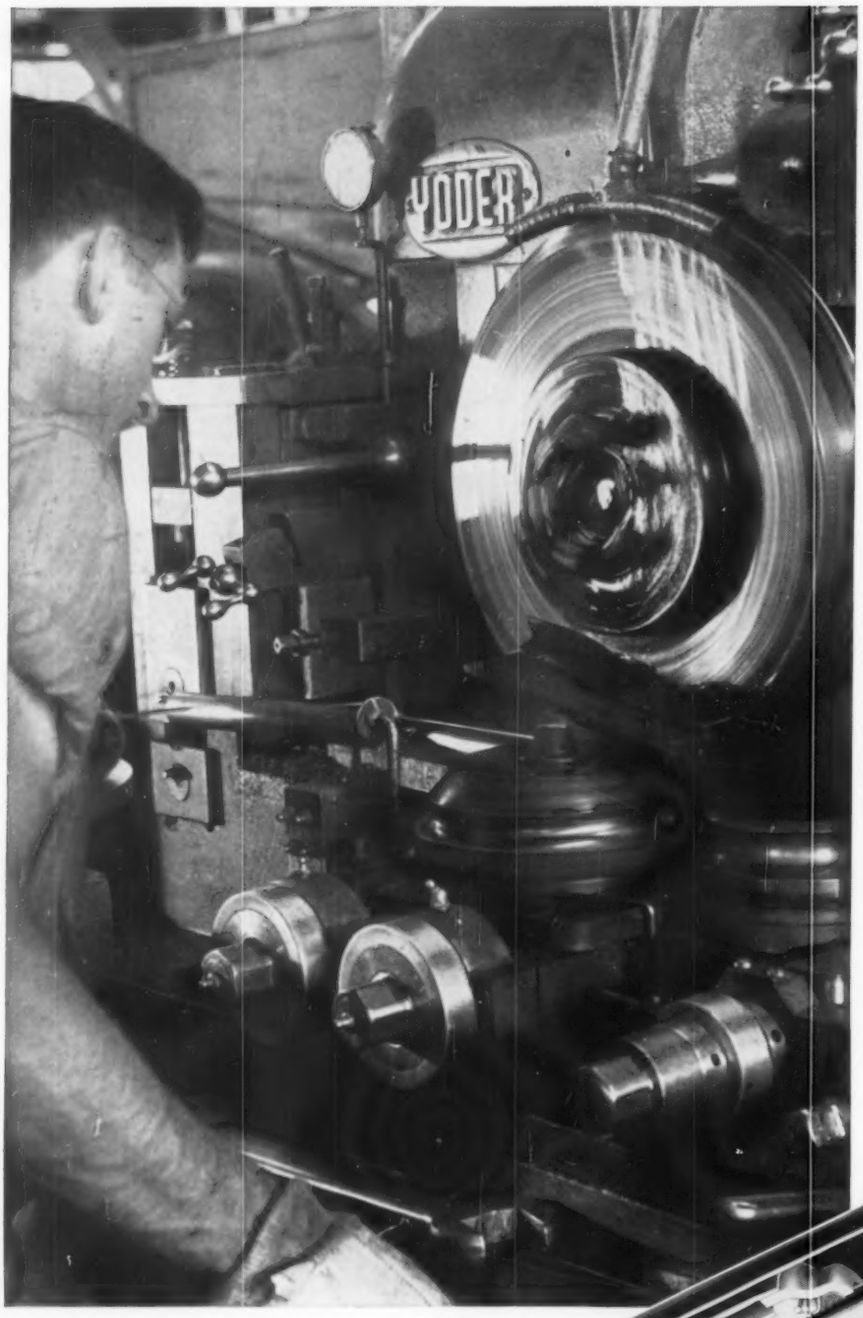
EF direct gas fired special atmosphere forced circulation, single stack circular bell steel strip annealers, each accommodates three 48" x 40" 15,000 lb. coils (45,000 lbs.)



Part of another installation of large EF gas fired three-stack rectangular bell type forced circulation special atmosphere furnaces for annealing steel strip.



EF gas fired special atmosphere rectangular bell type strip annealers with individually controlled forced circulation three-stack bases each with capacity of 135,000 lbs. per charge.



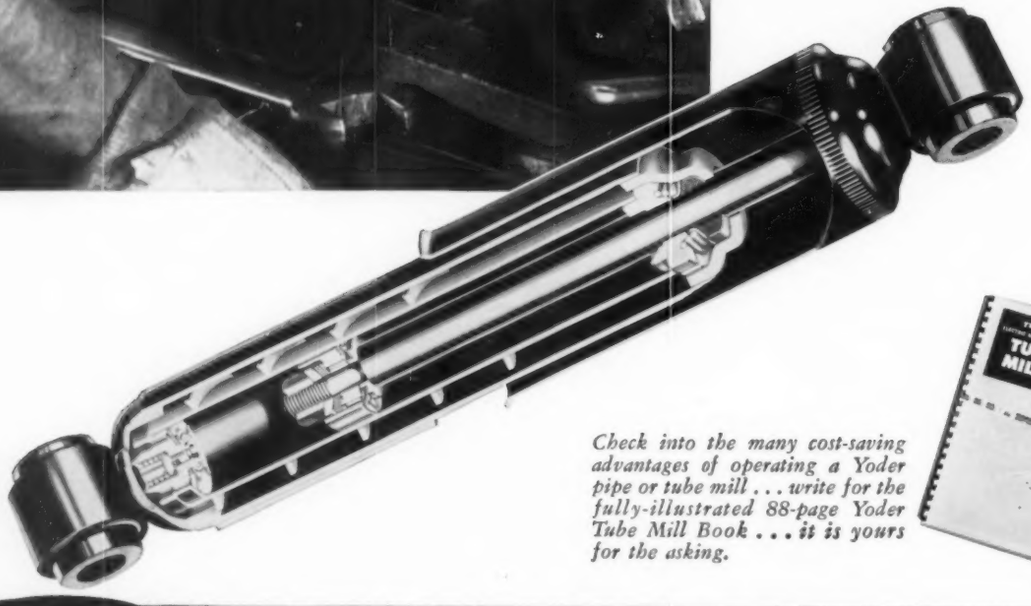
Monroe Shock Absorbers rely on performance of YODER Tube Mills!

After 15 years of continuous operation the Yoder Type-M Electric-Resistance Weld Tube Mill shown here, is still producing precision tubing for the Monroe Auto Equipment Co., Monroe, Michigan.

Yoder produced tubing is the basic component of the famous "Monro-Matic" shock absorber. Measuring 2 1/64" outside diameter (plus several other sizes) the tubing is made from 22 gauge strip in one continuous operation . . . it is automatically cold-roll formed, welded and cut to pre-determined lengths.

This typical installation of a Yoder tube mill exemplifies the accuracy, dependability and production economies of Yoder-made tubing. If your business requires pipe or tubing, ferrous or non-ferrous, in sizes from 1/4" to 26" diameters, there is a Yoder mill designed to produce it economically, efficiently and accurately.

THE YODER COMPANY
5495 Walworth Avenue • Cleveland 2, Ohio

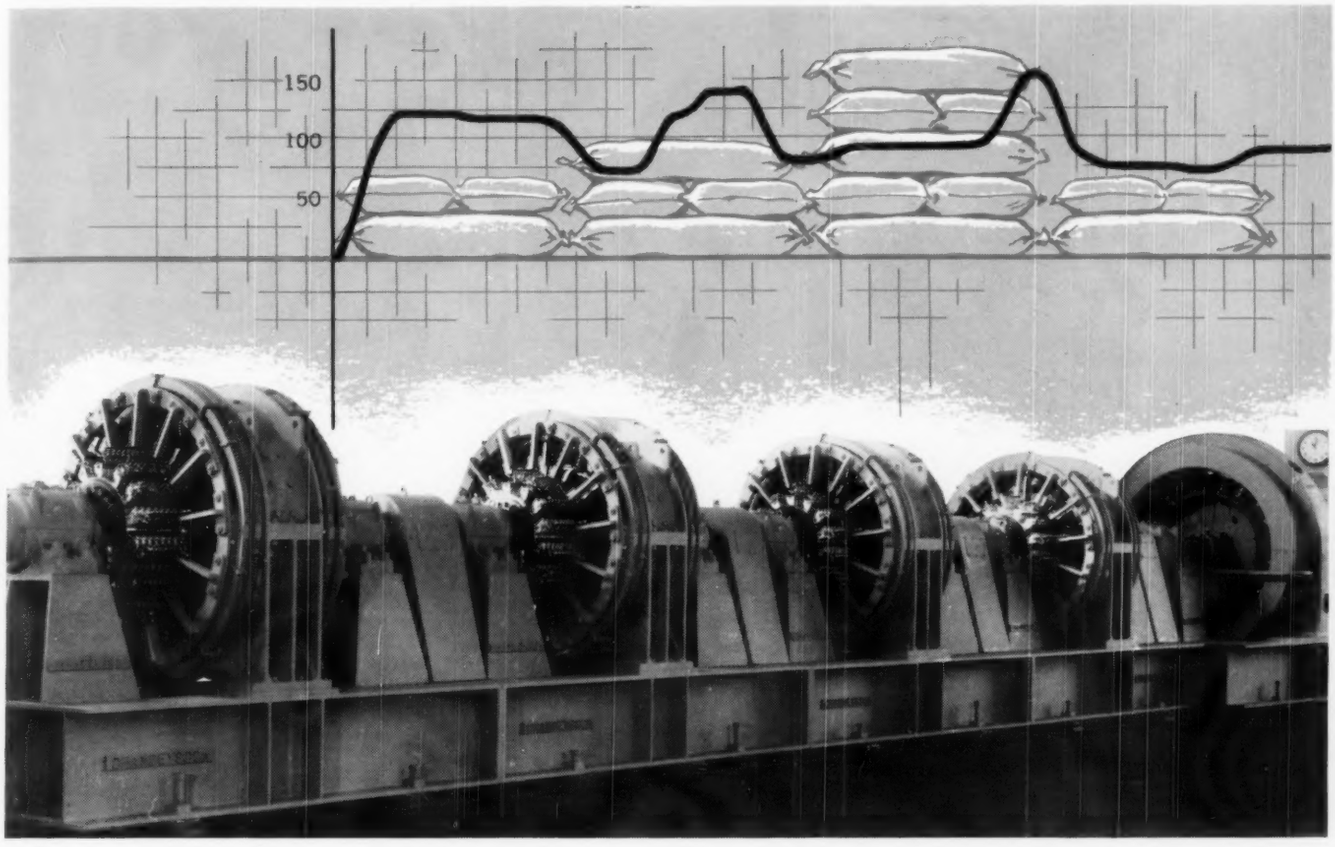


Check into the many cost-saving advantages of operating a Yoder pipe or tube mill . . . write for the fully-illustrated 88-page Yoder Tube Mill Book . . . it is yours for the asking.

ENGINEERING **YODER** MANUFACTURING

PIPE AND TUBE MILLS (ferrous or non-ferrous)
COLD ROLL FORMING MACHINES
ROTARY SLITTING LINES

EXTRA stamina...WHEN YOU NEED IT MOST



...PROOF THAT MOTOR GENERATORS ARE YOUR MOST DURABLE FORM OF POWER CONVERSION

Chandeysson **generators are built with high overload capacity—up to 50% momentarily**

Stamina and durability are built right into Chandeysson Motor Generators to give you more power when you need it most . . . in an emergency. You get overload capacity as great as 50% momentarily and 25% for 2-hour periods . . . without distress or damage. All *this* is the result of Chandeysson's sound engineering, painstaking design, specialized craftsmanship, and thorough testing.

Stamina is just one of many reasons why the plating industry *insists* on Chandeysson low-voltage generators for direct current power needs . . . for extra capacity to meet emergencies at the lowest possible cost.

For full information, write now for new booklet D-103.

CHANDEYSSON ELECTRIC COMPANY

4076 Bingham Avenue • St. Louis 16, Missouri

Area Meter is designed for measuring viscous fluids such as tar or Bunker C. Meter body readings are transmitted electrically to an evenly graduated indicating or recording instrument. Capacity, based on water, varies from 0-150 to 0-2,000 gallons per hour.

***ElectroniK* Flow Recorder** incorporates electronic integration. It is available with air control and can be used with an evenly graduated or square root type meter body or a bell type low-pressure meter.

Interchangeable Range Tubes and interrelated charts permit you to change flow meter to any range without disturbing orifice connections.

Differential Converter is a mercuryless flow transmitter with square root calibration, pneumatic transmission, and infinite rangeability between 5" and 1000" of water. Measures gas and liquid flow or liquid level with accuracy within ± 1%.

Ratio Flow Controller automatically maintains proportions of one or more flows in relation to a primary flow. It records the uncontrolled flow and the secondary or controlled flow on the same chart.

Choose the exact features you require...from the complete line of Honeywell flow meters

Why be restricted to one type of flow meter and possibly have to change your process to fit the meter? The completeness of the Honeywell line of flow meters lets you choose the best possible type of meter for any application... choose the specific features you need from a wide variety.

You can select either square root or linear calibration . . . mercury or mercury-less or area type manometers . . . pneumatic or electric transmission or mechanically connected instruments. Whether you want to meter air, oil, gas, or most any other fluid, you'll find the exact instrument you need in the Honeywell line—a line unmatched by any other manufacturer.

Your nearby Honeywell field engineer can give you valuable help with your flow metering problems. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division,* Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

H HONEYWELL

First in Controls

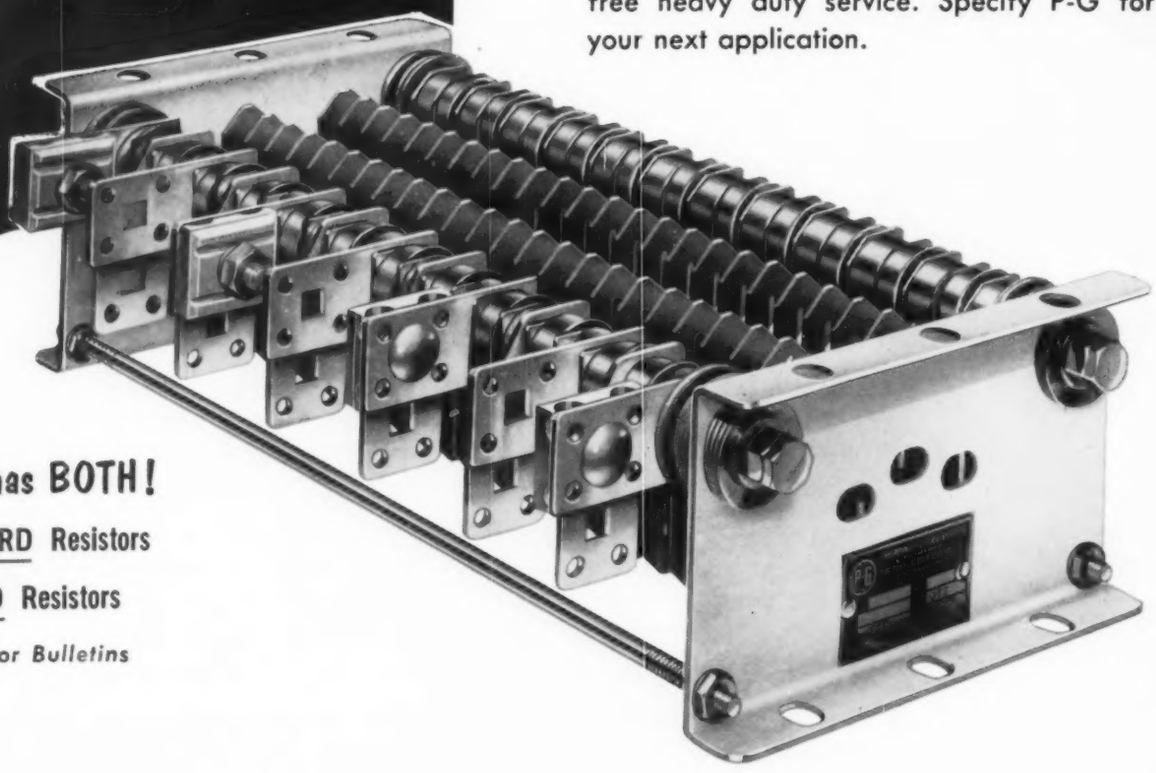
MEET *All* REQUIREMENTS

... *correct* OHMIC VALUES

... *plus* AMPLE CAPACITY

P-G *Steel Grid Resistors*

Use resistance grids punched from many gages of resistor steel. Thus it is easier for P-G to meet correct ohmic values and still furnish the capacities necessary for each job. Ability to meet both requirements is assurance of accurate control with full protection for your electrical equipment. All steel construction, mica insulation, with provision for expansion and ample ventilation give that extra stamina needed for trouble-free heavy duty service. Specify P-G for your next application.



P-G has BOTH!

STANDARD Resistors

WELDED Resistors

Write for Bulletins

The Nonbreakable Steel Grid Resistor

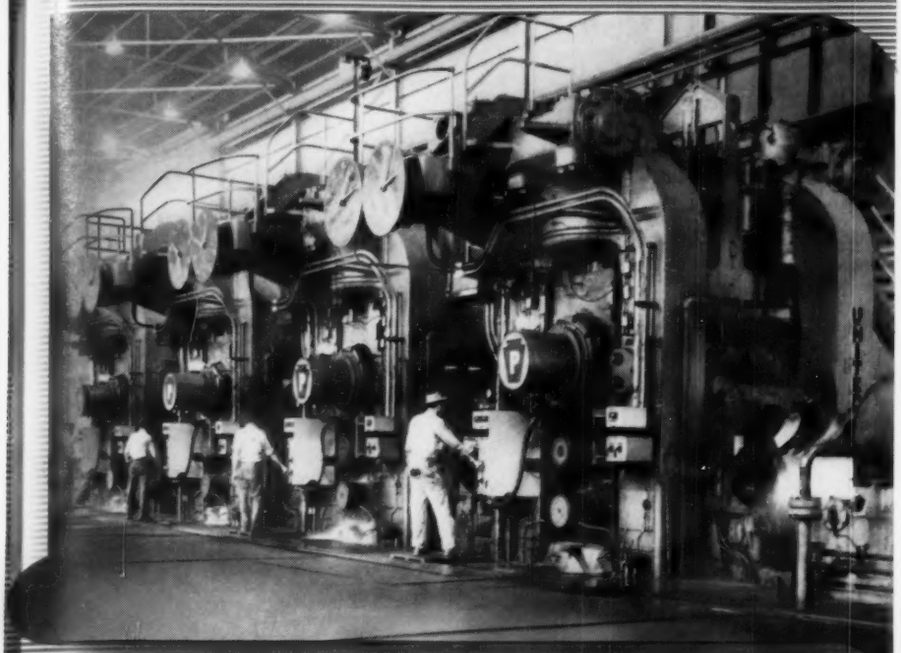
P-G

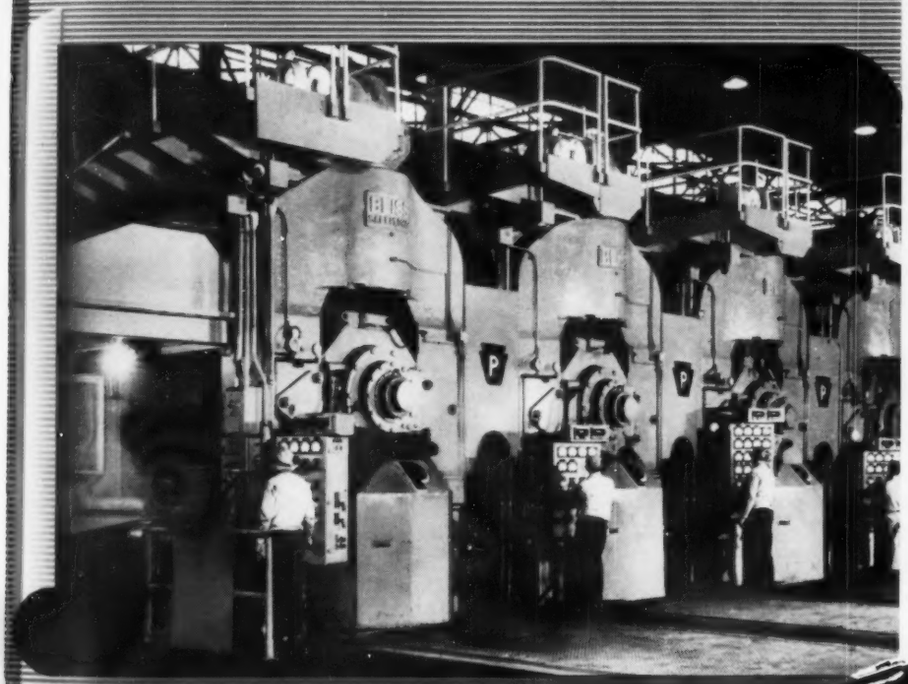
ESTABLISHED 1892

THE **POST-GLOVER** ELECTRIC COMPANY

OFFICE and FACTORY—Kenton Lands Road, Erlanger, Kentucky

MAILING ADDRESS—Box 709, Covington, Kentucky



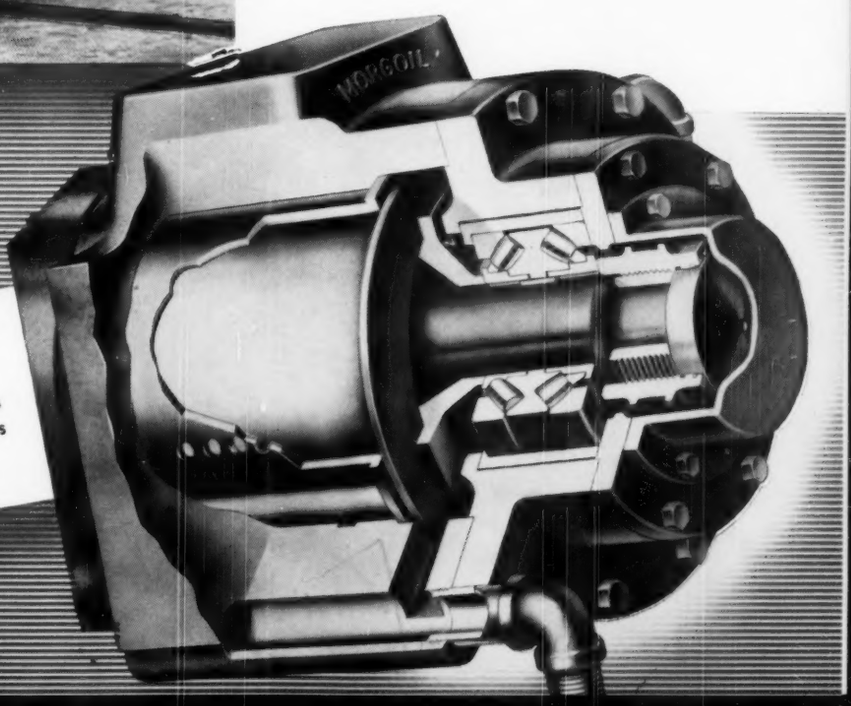


Hot Mills or Cold Mills **MORGOILS** give Top Performance

In the modern Allenport plant of Pittsburgh Steel Co. both the Hot Mills and Cold Mills roll on MORGOIL BEARINGS.

Whatever the rolling requirements MORGOIL equipped mills excel in performance and low maintenance costs.

MB-26



MORGAN CONSTRUCTION CO.
WORCESTER, MASSACHUSETTS

Rolling Mills - Morgoil Bearings - Wire Mills
Regenerative Furnace Control - Ejectors - Gas Producers

NEWS!

AVAILABLE FROM SHELF STOCK –

TAYLOR POTENTIOMETER TRANSMITTERS

CALIBRATED TO YOUR SPECS.

NOW we can offer you immediate delivery of the 700T Taylor TRANSET* Potentiometer Transmitter—custom-equipped for your specific application. **It's the unique** plug-in features of this instrument—plug-in amplifier, plug-in transducer, plug-in service "cans"—that make it so superior and so readily adaptable to your needs. *And it's these same benefits of flexibility that permit us to fill your orders so promptly.*

Plug-in service "cans" means that the instrument can be quickly adapted for use with different primary elements by simply plugging in the corresponding can. (For thermocouple applications cold junction compensation is provided in the can).

Just one amplifier. You change its service by switching service cans. Both the amplifier and the transducer plug-in . . . means minimum instrument down-time for service. Also means low instrument inventory because you only need one spare amplifier.

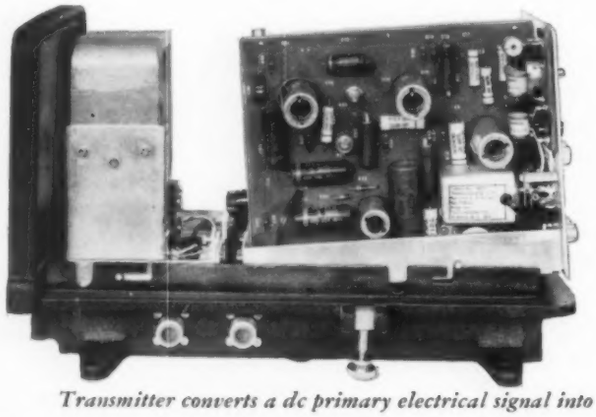
*Reg. U.S. Pat. Off.

Check these additional benefits: • Infinitely sensitive to input signal. • High order of linearity and accuracy. • No moving parts such as slidewires, batteries, or standard cell. • Continuous vernier range adjustment. • Continuous vernier zero or suppression adjustment. • Convenient front panel checkout and adjustment. • Printed circuit, for completely uniform performance. • Thermocouple burnout protection, either up or down scale.

Acknowledged by users as the finest instrument of its kind on the market, the TRANSET Potentiometer is ideal for processes permitting the use of pneumatic receivers and controllers, whether large case or miniature. Its outstanding flexibility permits a narrow or wide range span according to process demands.

• • • •

Call your Taylor Field Engineer, or write for **Catalog 98262.** Taylor Instrument Companies, Rochester, N.Y., or Toronto, Ontario.



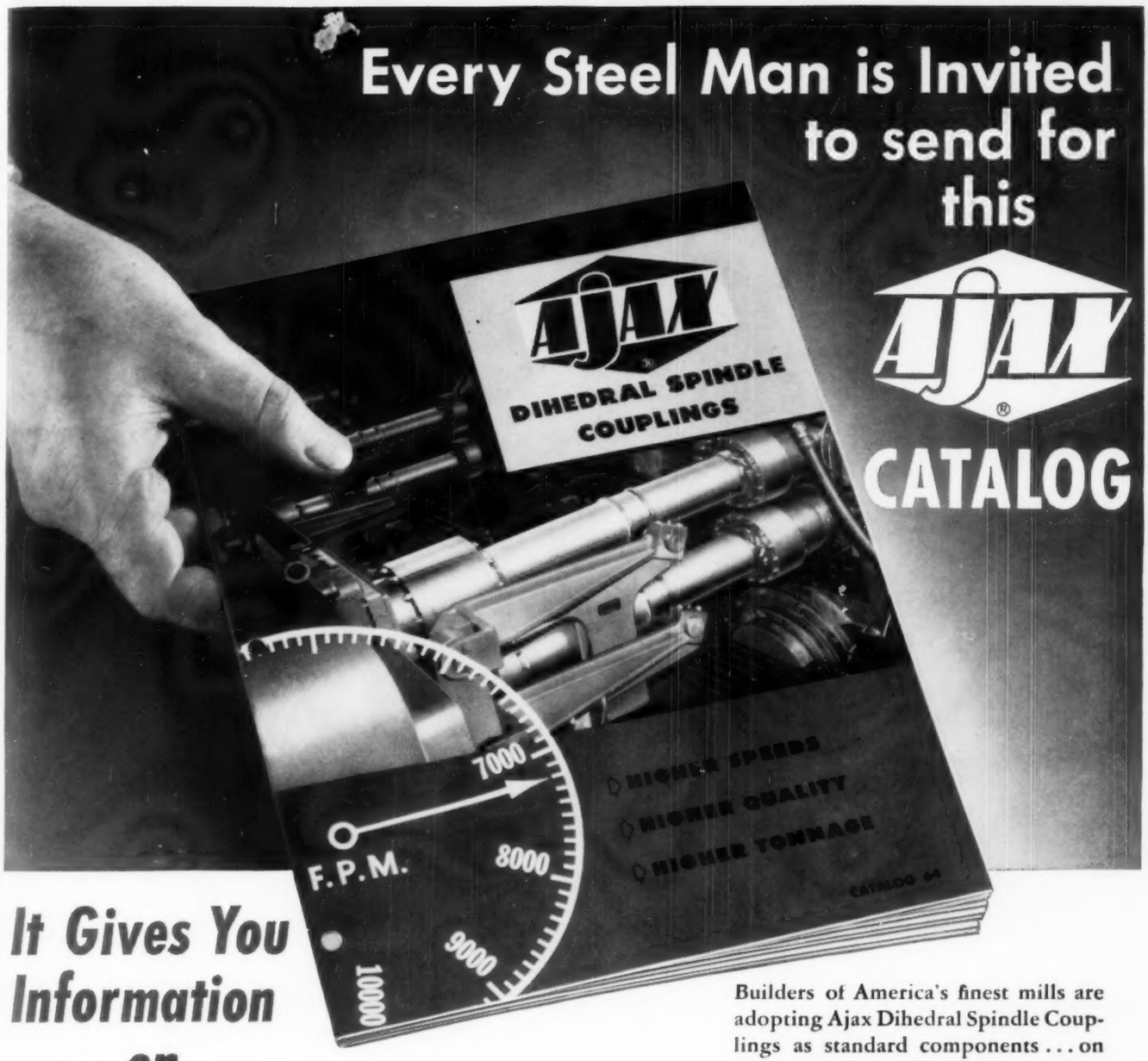
Transmitter converts a dc primary electrical signal into a 3-15 psi pneumatic output for controllers and receivers.

INSTRUMENTS IN STOCK WITH THESE PRIMARY ELEMENTS

THERMOCOUPLE . . . *Copper-Constantan . . . Iron-Constantan . . . Chromel-Alumel*

VOLTAGE . . . *For pH; strain gages; tachometers; 0-50 mv.*

Taylor Instruments MEAN ACCURACY FIRST



It Gives You Information on

AJAX DIHEDRAL SPINDLE COUPLINGS

Whether you are responsible for engineering, production, quality control, or maintenance, you will find this new catalog helpful. It gives the facts on how AJAX Dihedral Spindle Couplings are helping steel men increase output, improve product quality, and reduce shutdown and maintenance costs.

AJAX FLEXIBLE COUPLING CO. INC.
WESTFIELD, N. Y.
Representatives in Principal Cities

Builders of America's finest mills are adopting Ajax Dihedral Spindle Couplings as standard components . . . on heavy-duty hot mills, high speed strip mills and package mills producing shim stock and foil, both ferrous and non-ferrous. They are also being used for modernizing existing mills with consequent improvement in operation and economy.

Write, phone, or send this handy coupon for your personal copy of this new AJAX Dihedral Spindle Coupling Catalog No. 64.

AJAX FLEXIBLE COUPLING CO. Inc.
WESTFIELD, N. Y.

Please send new AJAX Dihedral Spindle Coupling Catalog No. 64 to my personal attention.

Name_____

Company_____

Address_____

Unmasking a Myth* about OXYGEN

the Myth:

Reliability of oxygen supply is possible only through hauled-in liquid oxygen generated at remote central stations.

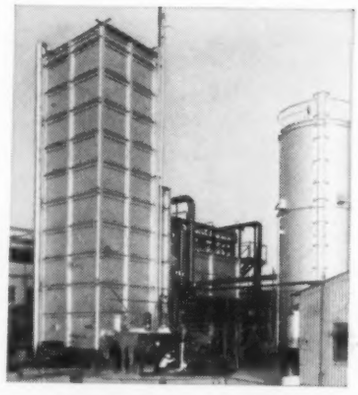
the Fact:

Operating records prove that Air Products on-site systems provide complete reliability.

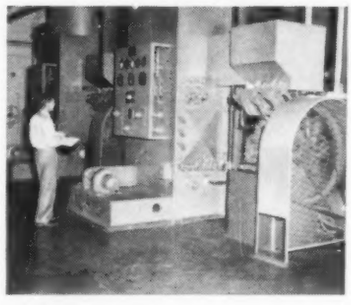
In 17 years, no Air Products customer has ever been without oxygen.

the Reasons:

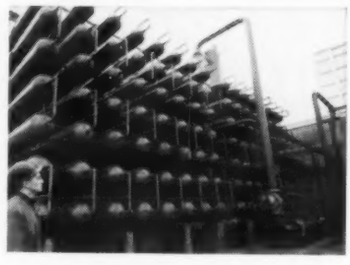
1. Single Air Products generators regularly operate one year without any shutdown whatsoever.



2. Multiple generator installations assure constant supply regardless of shutdowns for maintenance and defrosting.



3. Generator-fed storage systems — for both liquid and gas — provide instantly available reserves as positive insurance against *any* shutdown. These systems may be made independent even of outside power supplies... can contain many days' supply of oxygen.

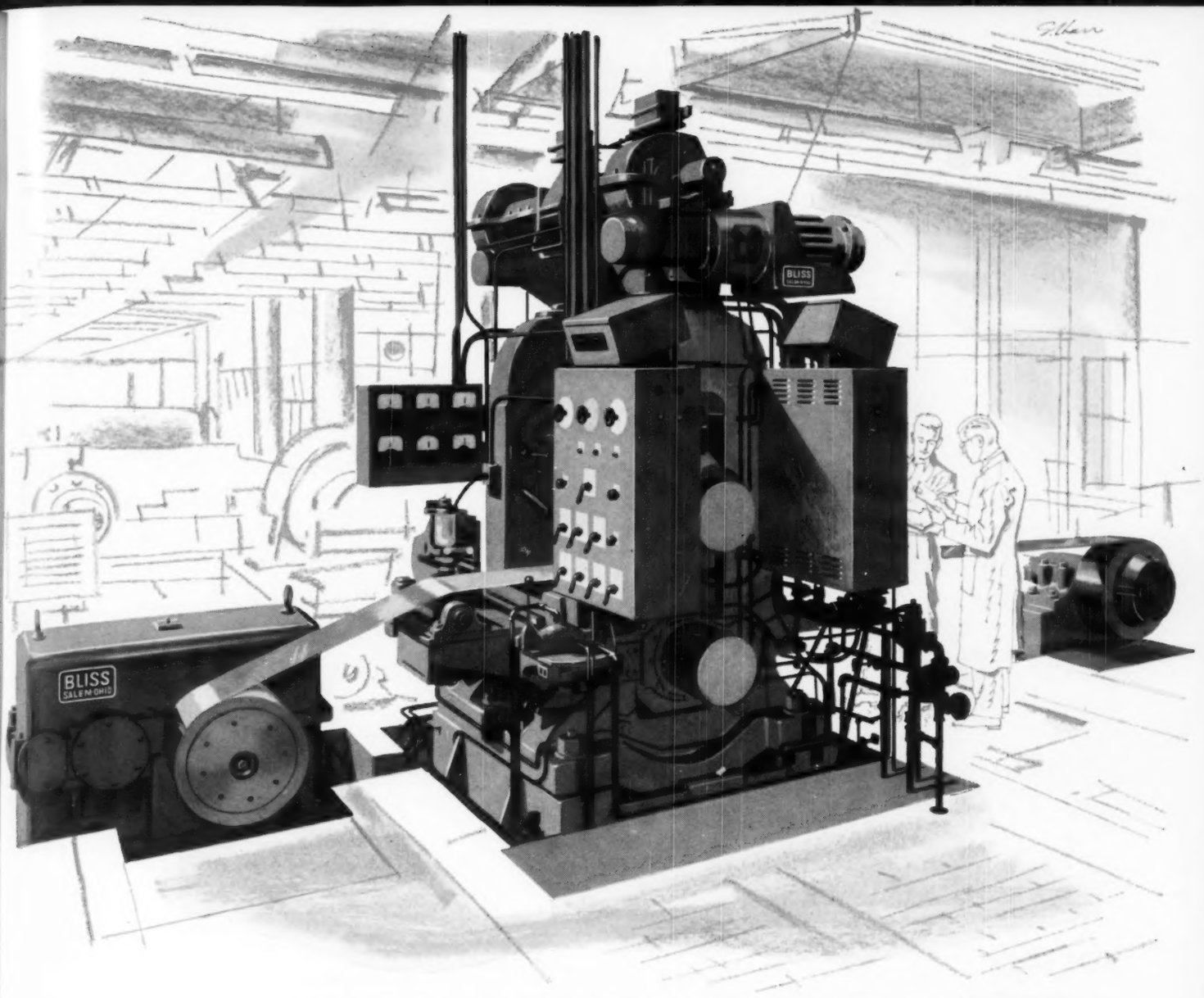


Air Products has unmasked many myths about oxygen generation and use. For all your needs . . . oxygen, argon and hydrogen . . . Air Products offers reliable supply systems erected on your property or immediately adjacent, providing gas at a guaranteed cost, with no capital investment by the customer.

For the best answer to your gas supply needs, contact us at Allentown, Pa.

Air Products ...INCORPORATED

myth (mith), n. 1. A story, the origin of which is forgotten, ostensibly historical but usually such as to explain some practice, belief, institution, or natural phenomenon. (by permission from Webster's New Collegiate Dictionary © 1956, by G. & C. Merriam Co.)



This Bliss 4-high reversing mill is the principal unit in National Cash Register's new cold rolling department.

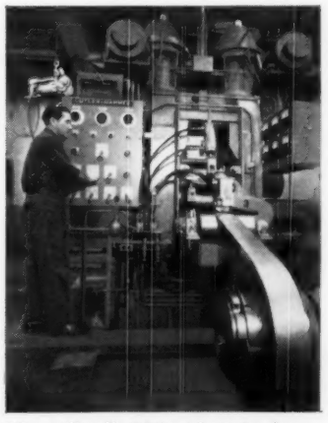
When does it pay to "roll your own"?

The National Cash Register Company's Dayton, Ohio, plant had a problem. It couldn't always get enough special strip for the stamped parts of its business machines.

National Cash Register solved the problem by deciding to "roll its own"—and then asked Bliss to help work out the equipment it would need. The end result is a complete cold rolling department, designed and built by Bliss. It includes a 4-high 5¾" and 16" by 12" reversing mill, a 14" shear line, and a 12" slitting line.

Today, National Cash Register tailors standard steel strip to the exact thicknesses, widths and lengths it needs. Its new Bliss equipment turns material out fast and economically, and there are no more shortages to plague the plant's press department.

This installation shows how Bliss engineers can solve a customer's problem. To see how Bliss has handled others, write today for a copy of the 60-page Bliss Rolling Mill Brochure, Catalog 40-A. It's yours for the asking.



Bliss mill rolls 10"-wide strip down to .009" at speeds up to 400 fpm.

BLISS
SINCE 1857

100 years of making metal work for mankind

E. W. BLISS COMPANY, Rolling Mill Division, Salem, Ohio

Subsidiary: The Matteson Equipment Company, Inc., Poland, Ohio

Why the LINK-BELT Series 100 is

TODAY'S MOST WIDELY ACCEPTED BELT IDLER

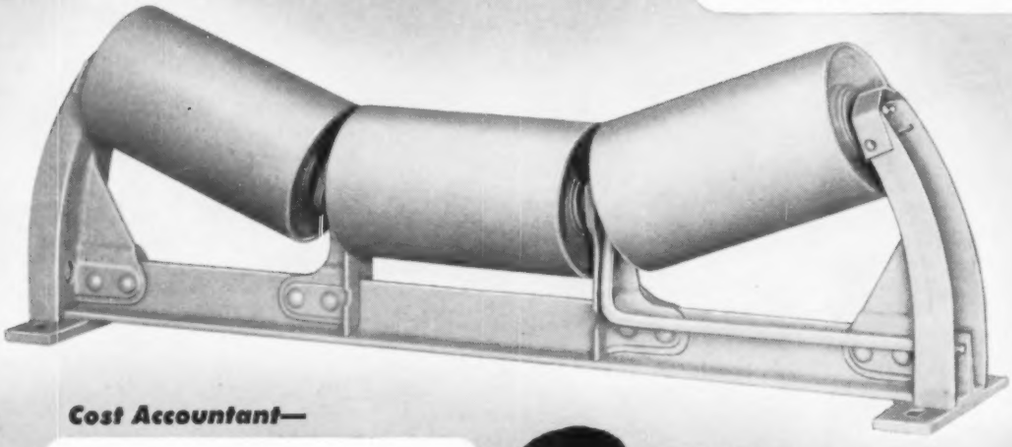
Here's what men who know idlers have to say

Superintendent—

"Service records of the Link-Belt Series 100 belt conveyor idler show that there's no more durable belt conveyor idler in the capacity range. It's a 'work horse'—gives economical service under hard duty, conveying all but the heaviest and coarsest materials."

Engineer—

"Look at these design features. Self-contained, concentric rolls with bearings fully enclosed and protected... strong heavy ribbed brackets and sturdy rigid frames maintain accurate roll alignment—won't spread under load . . . hex nuts that lock rolls in brackets, preventing shaft rotation."



Cost Accountant—

"All costs considered—installation, operation and maintenance. You won't find a better buy in belt conveyor idlers than the Link-Belt Series 100. Its free-rolling action requires less power . . . reduces wear on operating parts and belt . . . cuts replacements."

Maintenance Man—

"Its cartridge seal is the best I've seen . . . has no springs, clips and other small parts to lose . . . cuts servicing time when required. It's tops for keeping grease in, dirt out under the grimiest conditions. Grease fittings are protected, easy to reach."

Broad range of types meets all material and operating requirements

RUGGED . . . free-rolling . . . dirt- and dust-proof—the Link-Belt Series 100 belt conveyor idler combines these and other features for low-cost, dependable materials handling under severe, continuous service conditions. What's more, you have a wide choice of types for any requirement—whether you handle coal, sand, gravel or iron ore . . . sticky or free-flowing materials.

Sturdy rolls of the Series 100 are accurately machined for concentricity—welded for added strength and to keep out dirt and moisture. Smooth, round surfaces and edges prevent belt damage. As for dependability of its roller bearings—Link-Belt has *never* known a bearing failure due to overloading a Series 100 idler. Equally important, strong malleable iron brackets and sturdy, rigid frames maintain accurate roll alignment.

For facts on the Series 100 belt conveyor idler, see your nearby Link-Belt office or authorized stock-carrying distributor. Or write for Book 2416.

LINK-BELT

BELT CONVEYOR IDLERS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,493

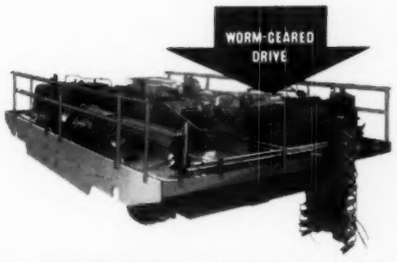
Crane control so exact you can polish your car

Polishing a $5,000 Mercedes-Benz with a cloth wrapped around a crane hook takes perfect control. Foolish idea? Not really. The hot and cold steel you handle and the equipment nearby are worth many times the cost of a quality car. That's why the total control provided by Shaw-Box is so vitally important to mills.

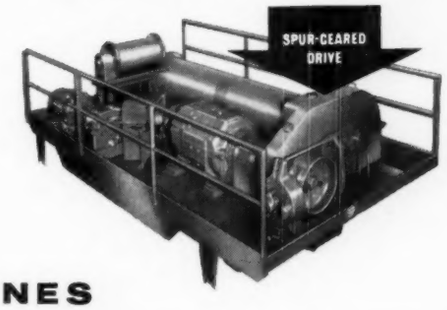
Shaw-Box Builds Cranes to AISE Specs or Your Own

You name the crane — any type, any size — Shaw-Box has the design and engineering experience and the facilities to meet AISE or your own specifications. You get total crane control that means everything in precision operation — everything in safety for man, load and crane. You can be sure of low maintenance and low power consumption. We assure complete dependability and highest performance regardless of service conditions.

Call in one of our engineers. He will gladly discuss specifications and tell you about our standard AISE designs for 5 to 500-ton cranes. Your inquiry is invited.



Prefer Spur-Geared or Worm-Geared Drive? Shaw-Box can meet AISE or your requirements exactly, whichever type is best for your application.



58K-2

"Shaw-Box"® CRANES

MAXWELL MANNING & MOORE INC. MM&M TRADE MARK

MANNING, MAXWELL & MOORE, INC.
SHAW-BOX CRANE & HOIST DIVISION
388 W. Broadway • Muskegon, Michigan

Builders of "SHAW-BOX" and LOAD LIFTER' Cranes, 'BUDGIT' and 'LOAD LIFTER' Hoists and other lifting specialties. Other Divisions produce 'ASHCROFT' Gauges 'HANCOCK' Valves, 'CONSOLIDATED' Safety and Relief Valves, and 'AMERICAN' and 'AMERICAN-MICROSEN' Industrial Instruments.

In Canada: ***Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario***

In open-hearth operations...

VALUABLE DATA MAY BE YOUR MAJOR STACK LOSS!

Knowing what goes up the stack is as critical to efficient open-hearth combustion practice as knowing what comes out the tap-hole is to quality.

A continuous, accurate analysis of the oxygen content of the waste gases can provide you with a reliable index to combustion efficiency . . . and with a guide to improved, more profitable combustion practice.

You'll find that "controlled" O_2 content means optimum fuel combustion, with maximum heat transfer to the steel bath . . . minimum carryover of combustibles with lessened refractory damage . . . shorter heats with increased output.

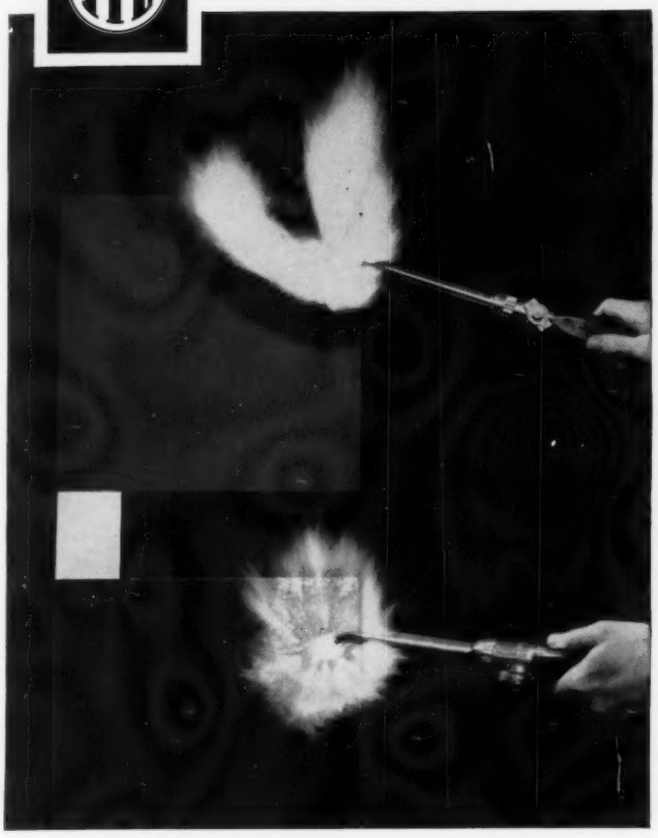
What specific plans are *you* making to improve combustion practice? If you've been hesitating . . . waiting to see what the trend will be in this important phase of open-hearth operation . . . don't delay any longer.

The trend is here . . . to L&N. We have the proven "hardware" . . . you have the essential "know-how" . . . let's get together.

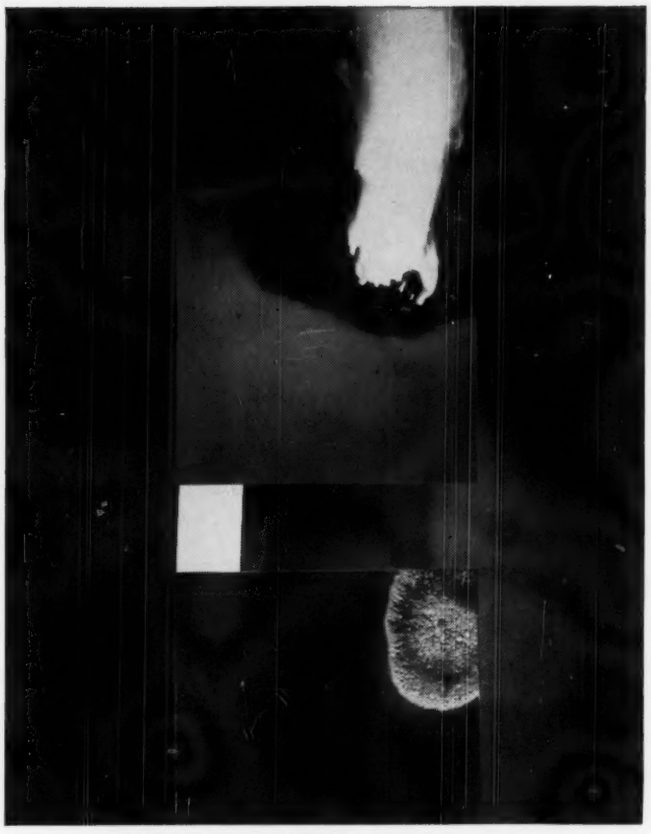
A call to your nearby L&N Field Engineer will bring all the details of this instrument package—specifications, prices, delivery. Call today . . . or write us at 4942 Stenton Ave., Philadelphia 44, Pa.

LEEDS Instruments **NORTHRUP** Automatic Controls • Furnaces

METAL-CLAD SWITCHGEAR



TORCHES IGNITE FLAMETRAP (bottom) and conventional insulation (top) simultaneously.



SECONDS LATER, FLAMETRAP has snuffed out, but conventional insulation still burns briskly.

New FLAMETRAP Insulation Snuffs Out Flame ...No Toxic Gases...Highest Arc Resistance

FLAMETRAP INTERPHASE BARRIER. Standard equipment on I-T-E 5 and 15 kv switchgear at no increase in price.

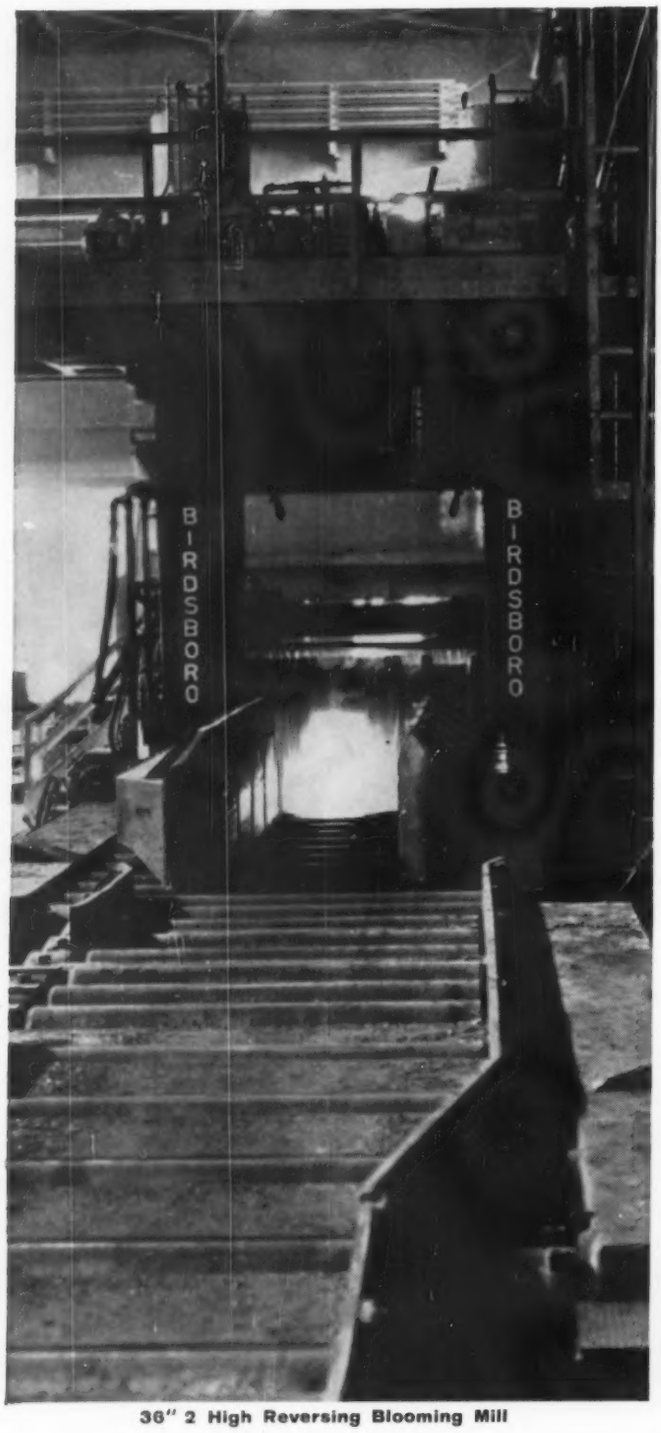
Take the heat away, and this new I-T-E developed **FLAMETRAP** insulation snuffs out . . . fast! This is today's most advanced flame-retardant insulation, and it is used exclusively in I-T-E Switchgear.

FLAMETRAP contains melamine resin—heretofore considered too expensive for commercial application. Unlike substitute ingredients, melamine gives off no toxic gases when it burns. So **FLAMETRAP** is far safer. And melamine stands up better under high temperatures. So **FLAMETRAP** suffers less from arc damage.

This latest improvement puts I-T-E switchgear even further ahead of the pack. It is one more of the quality details that keep coming your way from I-T-E without increase in price.

I-T-E service is as near as your telephone or mailbox. Why not call or write today. I-T-E Circuit Breaker Company, Switchgear Division, 19th & Hamilton Sts., Philadelphia 30, Pa. In Canada, Eastern Power Devices Ltd., Port Credit, Ont.

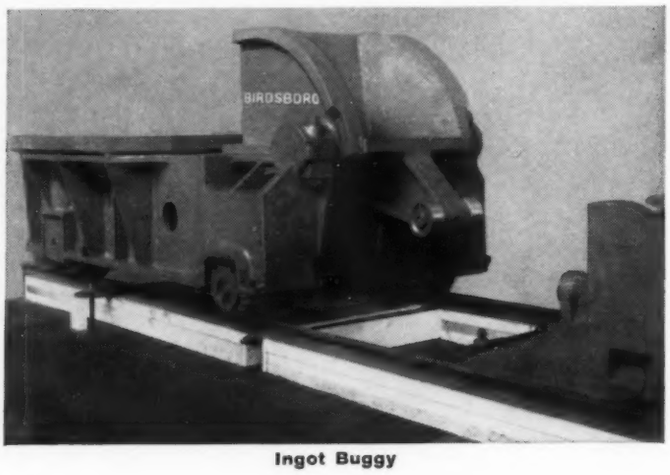
I-T-E CIRCUIT BREAKER COMPANY
PHILADELPHIA, PENNSYLVANIA



36" 2 High Reversing Blooming Mill

Transfer Tables

Front and Back Mill Tables and Manipulators



Ingot Buggy

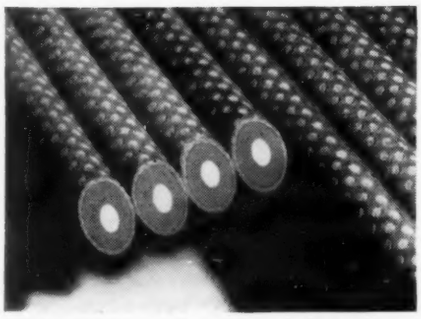
For a complete mill . . . or a customized unit

BIRDSBORO
STEEL FOUNDRY AND MACHINE CO.

Main Office, Engineering Department and Plant:
Birdsboro, Pa., *District Office:* Pittsburgh, Pa.

STEEL MILL MACHINERY • HYDRAULIC PRESSES • CRUSHING MACHINERY • SPECIAL MACHINERY •
STEEL CASTINGS • Weldments "CAST-WELD" Design • ROLLS: Steel, Alloy Iron, Alloy Steel

Trucks with New, More Powerful Battery Do More Work



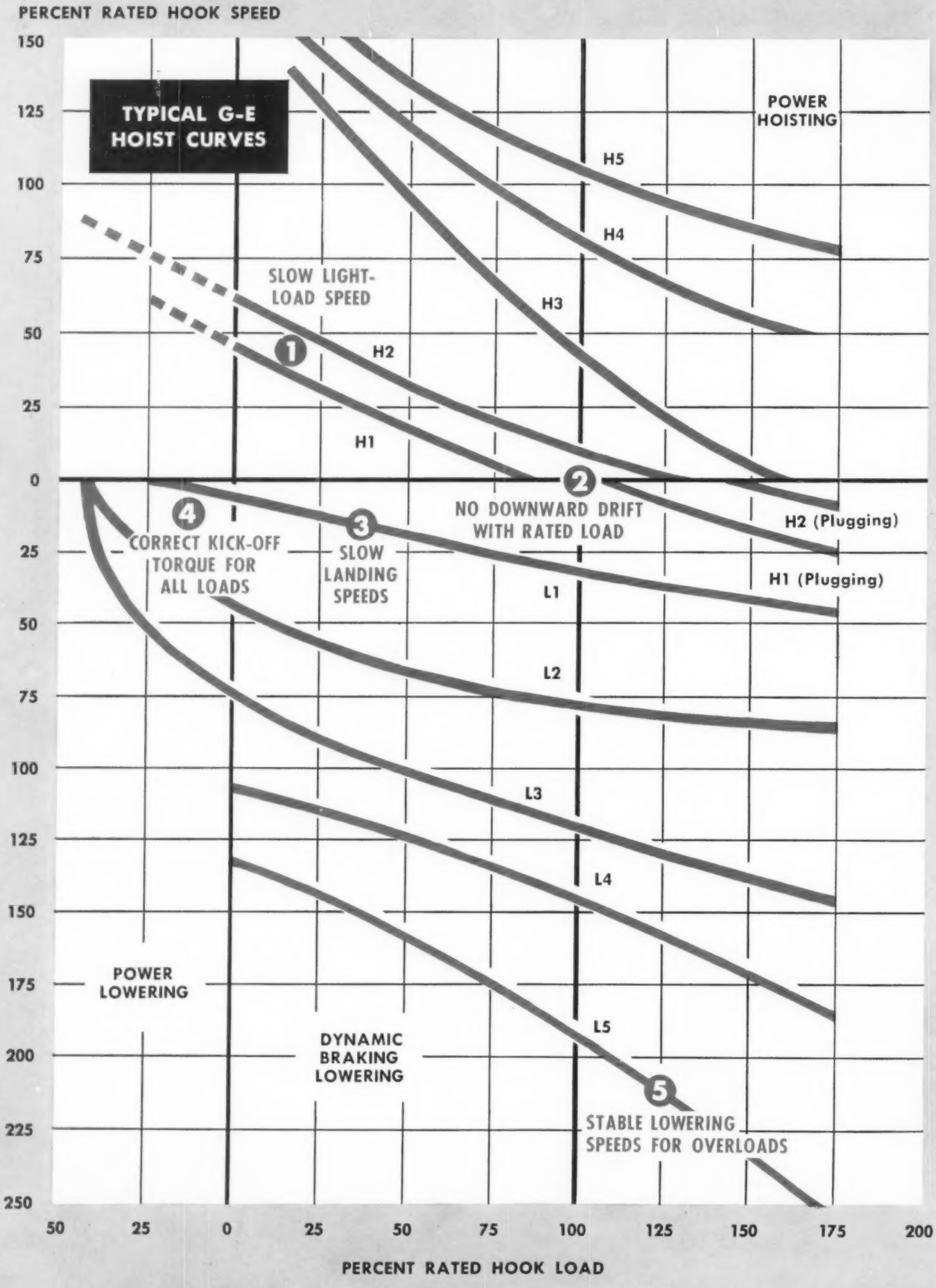
Here's the secret. Unique advanced tubular construction. Every positive plate packs more power. So you get greater battery efficiency—more power in the same size to fit your present trucks.

New Exide-Ironclad boosts work capacity... cuts cost

It packs up to 44% more power than other batteries you might buy. But costs less per work unit and has longer life potential. So you can step up the work output of your present trucks, get more done during every day, and without increasing your truck investment. Result: every power dollar buys you more in actual work done. Only Exide offers such a big power bargain today. If you want to make your dollars go farthest . . . right now and for years ahead . . . don't take less than the new Exide-Ironclad. For detailed bulletin, write Exide Industrial Division, The Electric Storage Battery Co., Philadelphia 2, Pa.

Exide®

THESE CURVES PROVE...NEW



GENERAL ELECTRIC DC CRANE CONTROL

TOPS ALL OTHERS IN SPEED-LOAD PERFORMANCE

The outstanding circuit design of General Electric's new d-c crane control brings you these important operating benefits:

1. **Slow light-load speed**—General Electric control gives slow-speed control of light loads on the first two hoisting points.

2. **No downward drift with rated load**—Even with 100 percent rated hook load, there is no downward drift on first-point hoisting. This means utmost protection for personnel and load.

3. **Slow landing speeds**—First lowering point maintains accurate speed control so there will be no appreciable difference in landing speed for light or heavy loads.

4. **Correct kick-off torque for all loads**—First point lowering gives sufficient kick-off torque to lower empty hook, yet will not cause slack cable. Initial torque is low enough to permit accurate jogging for heavy loads.

5. **Stable lowering speeds for overloads**—Heavy overloads can be lowered on any speed point without danger of overspeed, resulting in added safety for personnel and load.

Outstanding performance is only one of the benefits you get with General Electric d-c crane control. Others include easier maintenance and smaller floor-space requirements. Both resulting from the use of front-connected devices. These are three good reasons why you should specify General Electric d-c crane control. For more information, contact your G-E Sales Engineer, or use the coupon below. Industry Control Department, Roanoke, Va.

LESS FLOOR SPACE is required with the elimination of the back aisle and use of a more shallow enclosure.

Progress Is Our Most Important Product

GENERAL ELECTRIC

SEND TODAY!

To: Section A785-5
General Electric Co., Schenectady 5, N. Y.

Please send a copy of GEA-6434, "General Electric DC Crane Control", to:

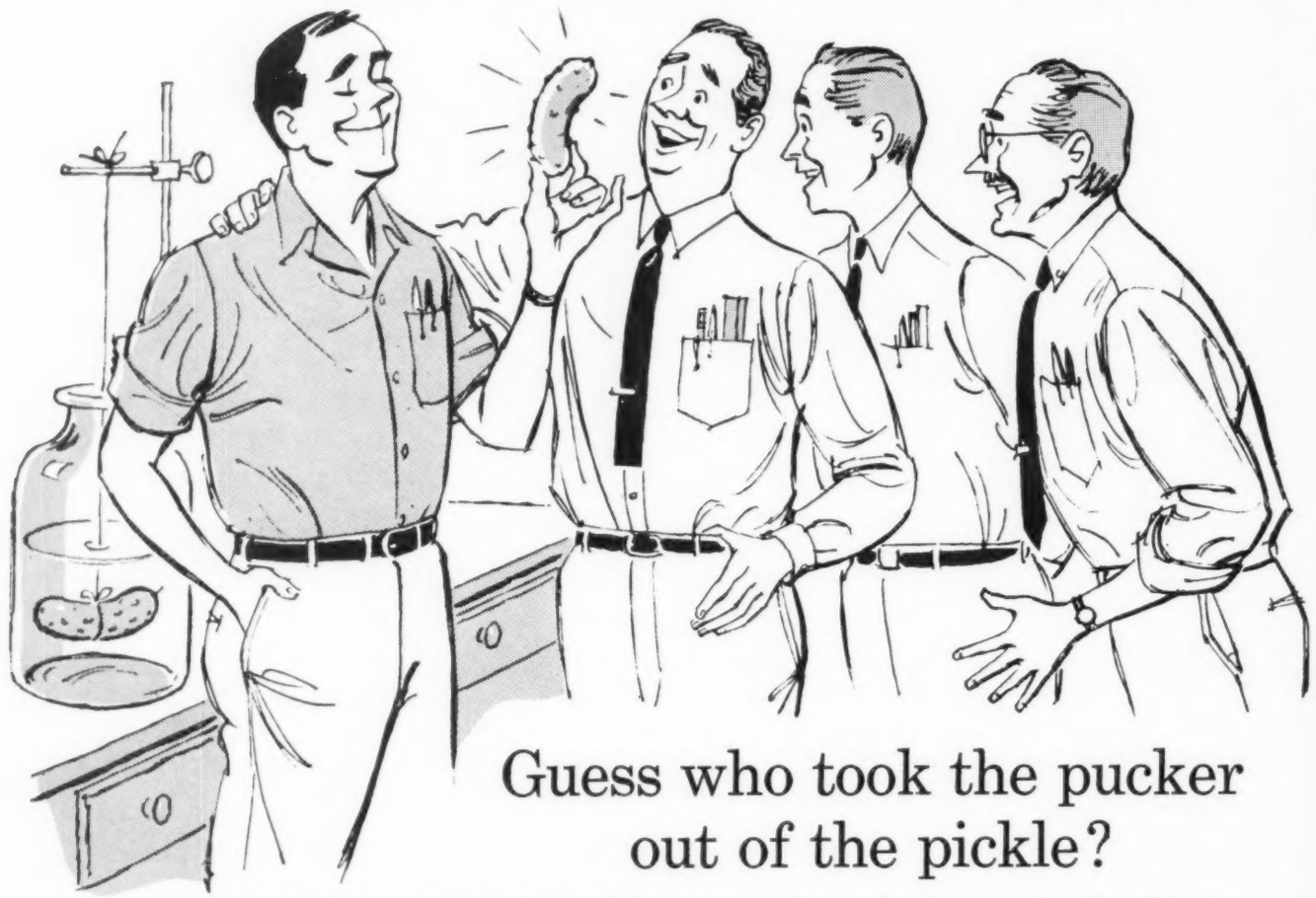
Name _____

Title _____ **Company** _____

Address _____

City _____ **State** _____

Any similarity to a real-life company is purely intentional



Guess who took the pucker out of the pickle?

If they had to rely on Barney Billet to keep the wolf from their doors, the pickle packers would soon pound a path to the poorhouse. For the truth is Barney doesn't like pickles. To him, a cucumber is just something to stay as cool as.

So what does Barney do for a living? Why he's a major-domo of a pickling tank at O-So-Strong Steel Company!

He does a good job — pushes plenty of tonnage through the tank. Barney rates ace-high with the top ingots (you wouldn't expect *brass* in a steel mill, would you?).

They've given him the finest equipment to work with. It's *got* to be good—the pickling operation uses a 12% sulphuric-acid solution at 200°F. And that can make a meal of most metals. But not of Ampco Metal! It's a series of special, super-tough copper-base alloys specially engineered to resist wear and corrosion.

That's why O-So-Strong fabricated the strip rollers and side plates from Ampco Metal. They're practically immersed in the pickling-tank solution—but meet the acid test without puckering.

Down the street, at the Even-Stronger Steel Company, replacement costs have dipped, also, since they've used Ampco Metal in pickling hooks, crates, baskets, yokes, and chains.

Ampco Metal has shown its mettle in other ways; for example, in rolling-mill applications where resistance to wear and shock loads is important — in screw-down nuts, screw-down worm wheels, slippers, breaker blocks, and other critical parts.

Though pickling may not have *you* in a pickle, chances are this story still applies to you. For nothing solves most wear, corrosion, erosion, abrasion, or cavitation problems like Ampco Metal. You can get it in any form — sand-cast, centrifugally-cast, shell-molded, precision-cast, forged, fabricated, extruded, sheet, or plate.

Your Ampco field engineer is the one to give you all the facts. Call him in. And write for Bulletin 33. *Ampco Metal, Inc., Dept. IS-3, Milwaukee 46, Wisconsin.*

(West Coast Plant: Burbank, California)

AMPCO® METAL

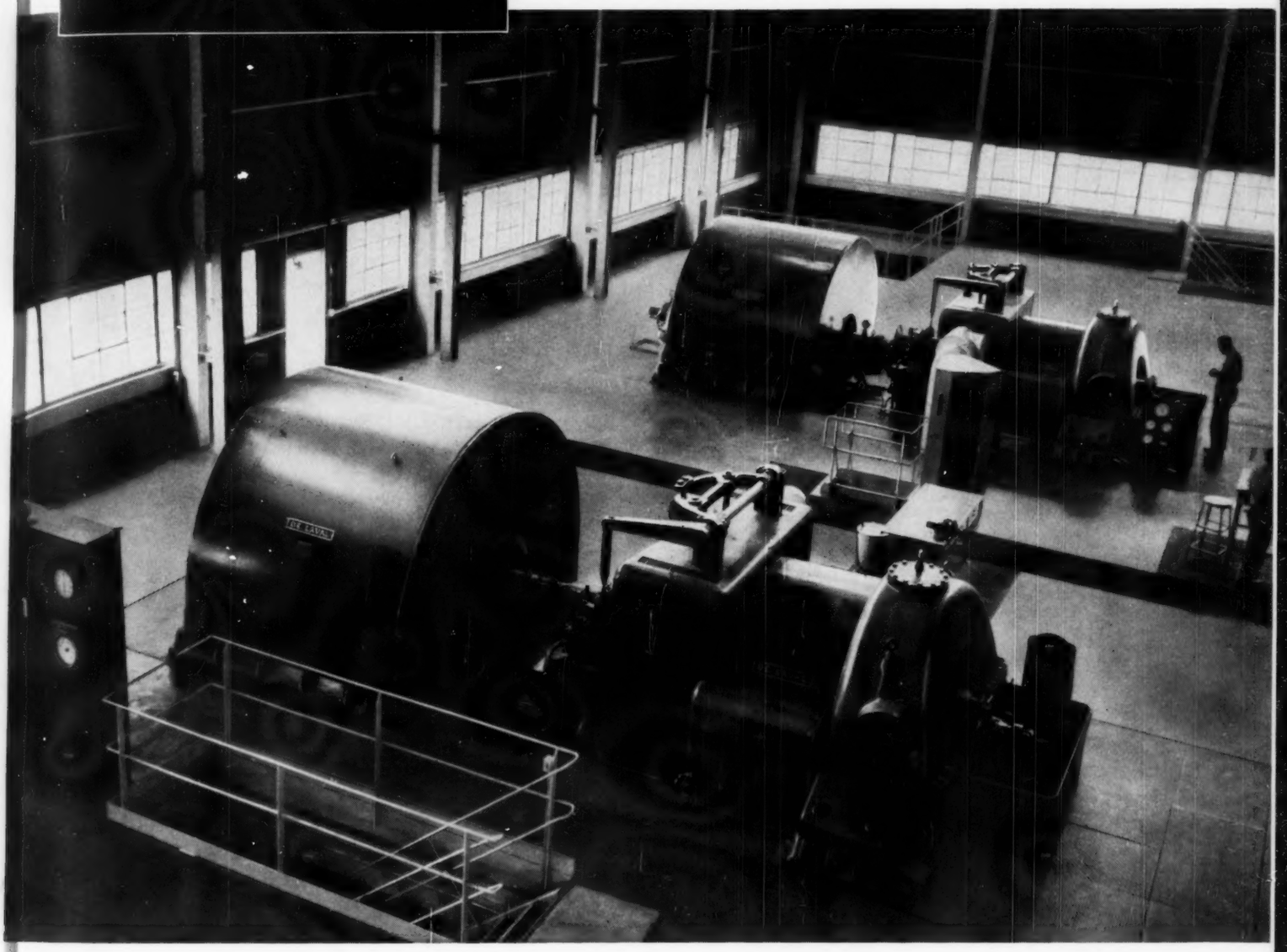
The metal without an equal

a-8

DE LAVAL

BLAST FURNACE BLOWERS

deliver 110,000 cfm each for McLouth Steel



These two De Laval turbine-driven centrifugal blowers do a round-the-clock job in the McLouth Steel plant, Trenton, Michigan. Each has a rated capacity of 110,000 cfm of air; discharge pressure is 30 psig. Each is driven by a 12,400 hp, 2950 rpm De Laval steam turbine operating under steam conditions of 600 psig, 825 F with 2″ hg.

De Laval compressors are designed individually for each application to assure maximum efficiency and range of operation. Construction is rugged throughout. Casings and perfectly balanced rotors are built to take punishment. All parts are precision-made to limit gages. Materials are selected which will best meet the particular conditions of corrosion, pressure and temperature.

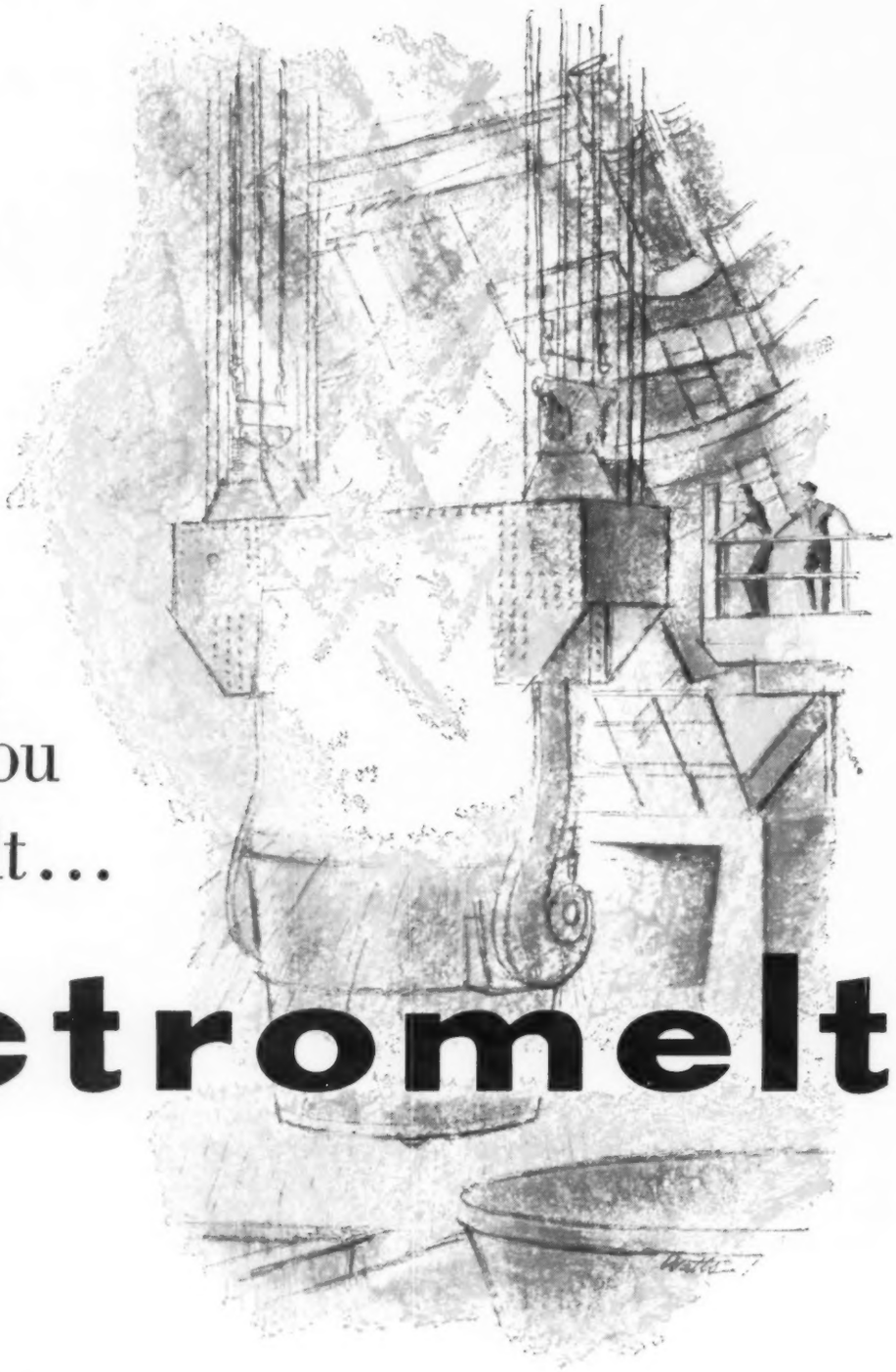
De Laval centrifugal blowers are built in single and multi-stage types to supply air in volumes up to 150,000 cfm for all classes of service in steel, gas and coke plants. The wealth of application experience acquired by De Laval over the years assures a correct and economical solution to your blower problem.

Send for Bulletin 0504

DE LAVAL *Centrifugal Blowers*

DE LAVAL STEAM TURBINE COMPANY

870 Nottingham Way, Trenton 2, New Jersey



When you melt...

Lectromelt*

McGRAW EDISON

In the United States

Lectromelt Furnace Division, McGraw-Edison Company
310 32nd Street, Pittsburgh 30, Pennsylvania.

and around the World

Forni Stein—*Genova, Italy*
Canefco Limited—*Toronto, Canada*
Electric Furnace Company, Ltd.—*Weybridge, England*
Demag-Elektrometallurgie, GmbH—*Duisburg, Germany*
General Electrica Espanola—*Bilbao, Spain*
Stein et Roubaix—*Paris, France*
S. A. Stein & Roubaix—*Bressoux-Liege, Belgium*

Catalog 10 describes efficient, time-proven Lectromelt furnaces and equipment.

. . . . simple hot mill passes studied on laboratory mills indicate that the most significant factors which affect the amount of turn-up and turn-down is the surface-speed ratio of the top and bottom rolls . . . . if the pass design is truly symmetrical, factors such as angle of entry, amount of edge working required, do not significantly alter the speed-ratio needed to produce a straight piece . . . .

Turn-Up and Turn-Down In Hot Rolling

by G. E. KENNEDY
Technologist
and F. SLAMAR
Research Engineer
Applied Research
Laboratory
U. S. Steel Corp.
Pittsburgh, Pa.

G. E. KENNEDY

F. SLAMAR

THE curvature of a bar emerging from a mill during hot rolling is dependent on many variables normally encountered in production rolling. Even a symmetrical roll pass and a pinion drive do not necessarily deliver a straight bar. When the roll pass is not symmetrical, as in the pass for structural shapes, the problem of curvature is even more complex.

Since the rolled bar must be flat within specified limits or flat enough to enter a succeeding pass, most of the curvature must be eliminated. Usually the pass is designed to inherently provide turn-down of the bar, with the guides and runout table providing the necessary straightening. The cost of rolling structural shapes could be appreciably reduced if this load on the guides were el minated, or greatly reduced. This paper describes an investigation that was made to determine whether curvature could be controlled during rolling.

PINION-DRIVE TESTS

In the initial phase of this work, tests were made on a 30-in., 2-high pinion-drive rolling mill at the United States Steel Corp.'s Applied Research Laboratory. Two passes were provided as shown in Figure 1: an unsymmetrical pass, with all side working in the top roll; and a symmetrical pass, with equal side working.

The following results were derived from tests made with a reduction of 25 per cent and a delivery speed of 80 fpm:

1. In general, the ratio of top-spindle torque to bottom-spindle torque for the pass of equal diameters and equal side working was 1 to 3.

2. In the unsymmetrical pass (top-roll diameter less than bottom-roll diameter), the top-spindle torque was negative, and the pieces turned up with a radius of curvature the same as the radius of the top roll.

3. All pieces rolled in the symmetrical pass, (equal roll diameters and equal side working) turned down.

When the top spindle was disconnected so that only the bottom roll was driven, all pieces in all passes turned up. The pieces that filled the passes turned up more severely than those that did not.

In considering angle of entry, the approach table was arranged to provide entry at angles of 7 degrees above and below the pass line, and on a level with the pass line. The tests were made in the pass with equal roll diameters and no side working. Within this range of angle of entry, the curvatures were all essentially the same, slightly turned down; however, the torque ratios varied from 0.33 to 3.5, as shown in Table I.

This preliminary investigation revealed that curvature was apparently more closely related to relative roll speeds than torques, and that a symmetrical pass with equal roll speeds did not necessarily ensure the delivery of a straight piece.

Figure 1 — An unsymmetrical and a symmetrical pass were initially used in the first stage of the work.

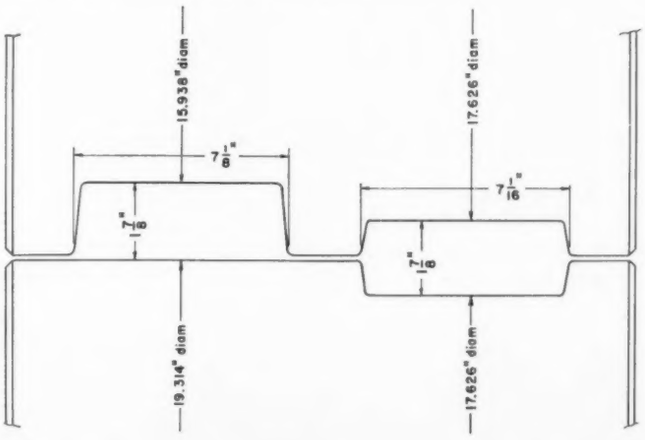


TABLE I

Effect of Angle of Entry on Torque Ratio with Equal Roll Diameters and No Side Working

Angle of entry	Top to bottom spindle torque ratio
7 degrees below pass line	0.33
0 degrees (level with pass line)	1
7 degrees (above pass line)	3.5

LOAD-REGULATED TWIN-DRIVE TESTS

From this initial investigation, it was apparent that some form of individual control of the rolls was required. Although a speed-regulated twin drive was indicated, it was decided to make additional exploratory tests with a load-regulated twin drive. This was done first because it was experimentally simpler, and because load-regulated twin drives are used in some commercial rolling mills.

To convert the mill to a twin drive, an additional drive was provided from the top roll, and the original motor was used for the bottom-roll drive. The top-roll drive consisted of two motors, each geared to the top roll to provide a 5 to 1 reduction from motor to roll. The original coupling from bottom drive to the bottom roll through the pinion stand was retained. The electrical system was arranged so that each drive was supplied from its own generator; a voltage-regulated system for the bottom drive, and a control for the top-roll drive maintained the armature current at a preset ratio of the bottom-roll drive current. This is shown schematically in Figure 2.

For these tests, the pieces were 2½ in. thick, were heated to 1900 F, the reduction was 25 per cent, and the angle of entry was zero. Since the stored energy of the bottom-roll drive was many times that of the top-roll drive because of the difference in gear ratios, the no-load speed of the top roll was usually set slightly high in an attempt to compensate for this unbalance.

The tests made under these conditions included such variables as filled and unfilled passes, symmetrical and unsymmetrical passes, and scaled and descaled slabs. Some of the slabs were rolled in the same position that they had in the furnace, and the rest of the slabs were turned over. A summary of the results of these tests is given in Table II.

Figure 2 — Control system used to regulate load on twin drive.

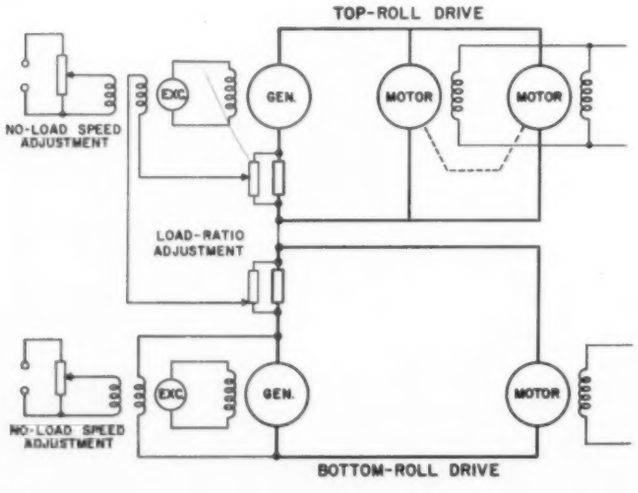


TABLE II

Preliminary Results with a Load-Regulated Twin-Drive Under Various Rolling Conditions

Curvature	Torque ratio, top to bottom	Speed ratio, top to bottom
Severe turn-up	0.7	0.96
Moderate turn-up	1.1	0.99
Straight	0.25 to 1.7	0.99 to 1.01
Moderate turn-down	0.4 to 1.1	1.0 to 1.01
Severe turn-down	0.65 to 0.9	1.03 to 1.04

The results indicated that under these tests conditions, torque ratio was a poor indication of curvature, but that there was a consistent relationship between speed ratio and curvature. This is in agreement with results obtained with the pinion drive, in which the angle of entry effected a torque-ratio change; whereas the speed ratio remained unity, and the curvature remained essentially unchanged. On the basis of the preliminary results, it was decided to conduct a balanced experiment with a speed-regulated twin drive.

SPEED-REGULATED TWIN-DRIVE TESTS

In designing this experiment, several objectives were established from the preliminary tests:

1. Both roll drives would be identical to minimize speed unbalances during transient conditions.
2. A relatively high gain feedback control system would be used for each roll drive to maintain the roll speeds with a high degree of accuracy.
3. All slabs would be descaled to more closely duplicate mill conditions.

The mill arrangement for these tests is shown in Figure 3. Each roll drive consisted of two motors geared to the roll through a 5 to 1 reduction. Two tachometer generators were geared to a motor in each drive to provide speed signals for regulation and instrumentation. The descaler was a commercial descaler applying water at high pressure through bars positional above and below the slab. A sufficient number of rolls were removed from the delivery table at the exit end of the mill to permit the delivered slab to fall freely to the floor. Thus the curvature was not affected by the delivery table.

Each roll drive with its own generator was individually speed-regulated to a reference common to both systems. Means were provided to permit relative speed changes between the two roll drives, as shown in the basic control scheme, Figure 4. The mill was instrumented so that oscillograms of the following quantities could be obtained: the voltage and current of each motor, the torque of each roll, the speed of the top motor and the difference between the speeds of the top and bottom motors. The tachometers were calibrated with electronic counters used in conjunction with pulse generators coupled to each roll.

One slab at a time was charged and heated in the furnace at 2300 F for 40 min. It had been previously established that slab temperatures reached equilibrium in the furnace 35 min after charging. Since the average time between removal from the furnace and rolling was 70 sec, the average rolling temperature was 2200 F.

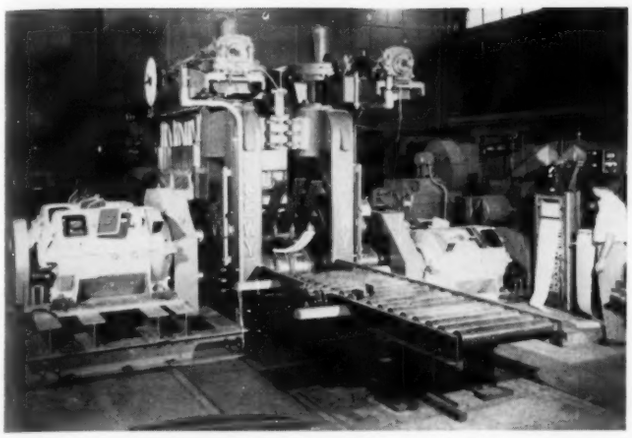


Figure 3 — Each roll drive has two motors geared to the roll through a five-to-one reduction.

All tests were made at a rolling speed of approximately 80 fpm and a fixed reduction of 25 per cent. For unfilled passes, a slab width of $4\frac{3}{4}$ in. was used, and for filled passes, a slab width of $6\frac{7}{8}$ in. The speed ratio as reported is the ratio of the surface speed of the top roll to the surface speed of the bottom roll.

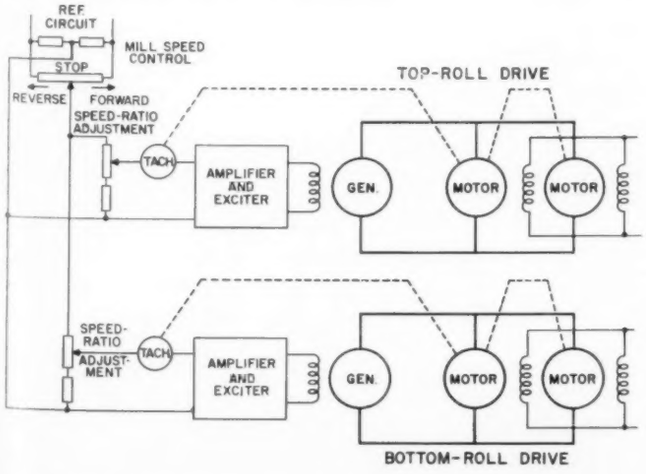
The variables considered were a range of speed ratios for filled and unfilled passes, −2- and 0-degree angles of entry, and symmetrical and unsymmetrical passes. A balanced randomized experiment was designed to determine the effect of these variables on the curvature of a slab as delivered from a mill, and on the distribution of torque between top and bottom rolls.

The data used for evaluating the results were limited to data obtained on each piece during the steady-state portion of rolling. In this experiment, curvature is defined as the ratio of top to bottom lengths of the rolled slabs. Typical results are shown in Figures 5, 6, and 7.

The test represented by Figure 5 was one in which the speed ratio was essentially constant at 0.98 over the entire length of the slab, despite the large impact speed drop of each drive at the head end. This produced a slab with a uniform curvature, as shown by the slab profile.

The test represented by Figure 6 was one in which the speed ratio was maintained at 0.95 for all but the initial 25 per cent of the slab, which represented the transient recovery period of the motors. Since the speed

Figure 4 — Basic control scheme permits relative speed changes between the two roll drives.



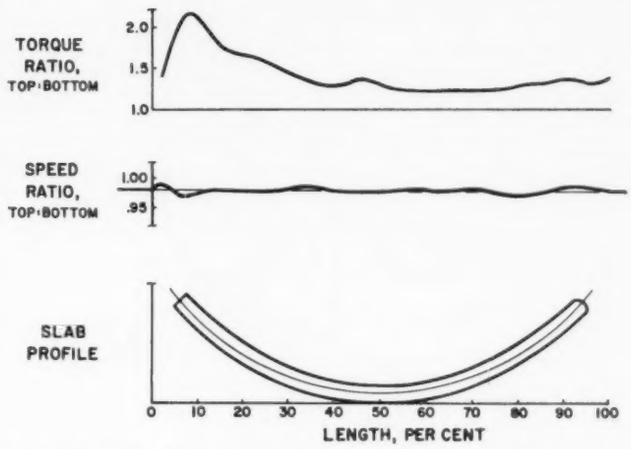


Figure 5 — Test results for filled unsymmetrical pass with entry angle of 0 degrees.

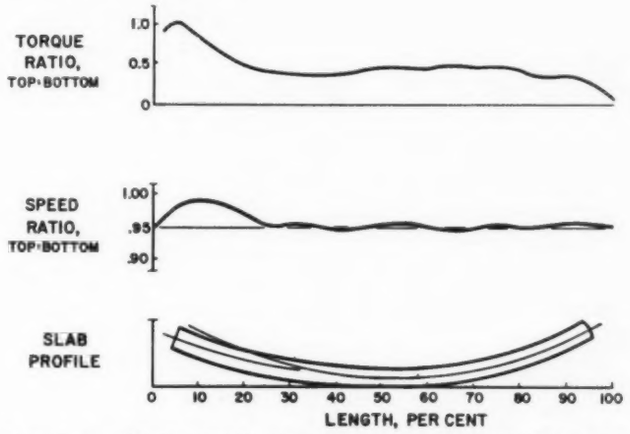


Figure 6 — Test results of unfilled unsymmetrical pass with entry angle of −2 degrees.

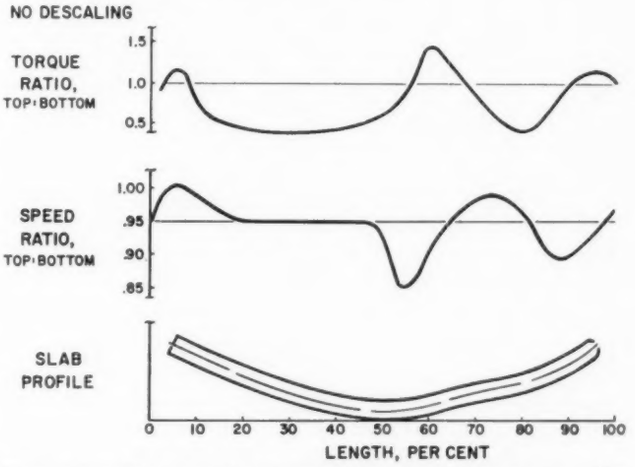


Figure 7 — Test results of unfilled symmetrical pass with entry angle of −2 degrees.

ratio was higher during this transient period, it would be expected that the corresponding portion of the slab would be turned up less than the main body of the slab. The slab profile shows that this was true.

The test represented by Figure 7 was not part of the balanced experiment, but was included to demonstrate a transient condition not encountered in the experiment. In this test, the slab was rolled without descaling. The speed-ratio curve shows that the speed ratio over the length of the slab was far from constant. The initial deviation was due to the head-end transient,

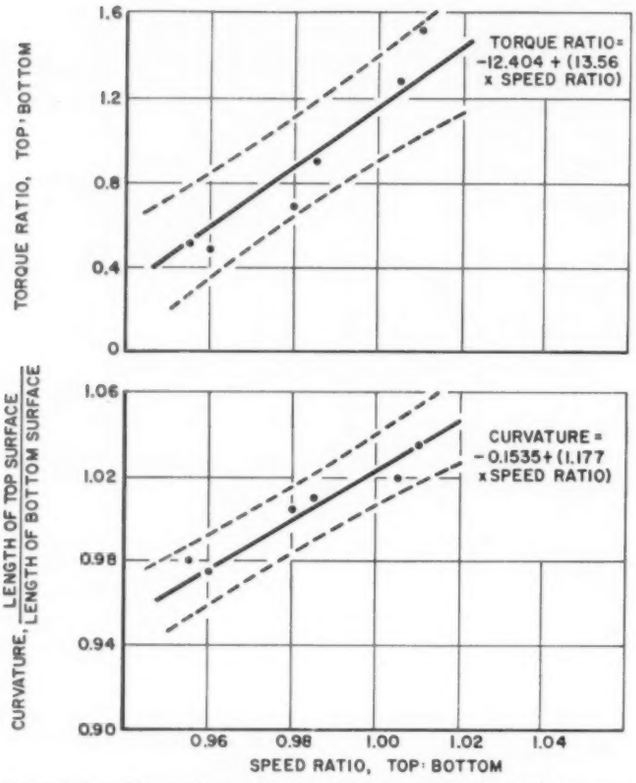

TORQUE RATIO, TOP : BOTTOM
TORQUE RATIO = -12.404 + (13.56 x SPEED RATIO)
CURVATURE, LENGTH OF TOP SURFACE / LENGTH OF BOTTOM SURFACE
CURVATURE = -0.1535 + (1.177 x SPEED RATIO)
SPEED RATIO, TOP : BOTTOM

Figure 8 — Empirical relations for curvature and torque ratios and speed ratios for symmetrical unfilled pass.

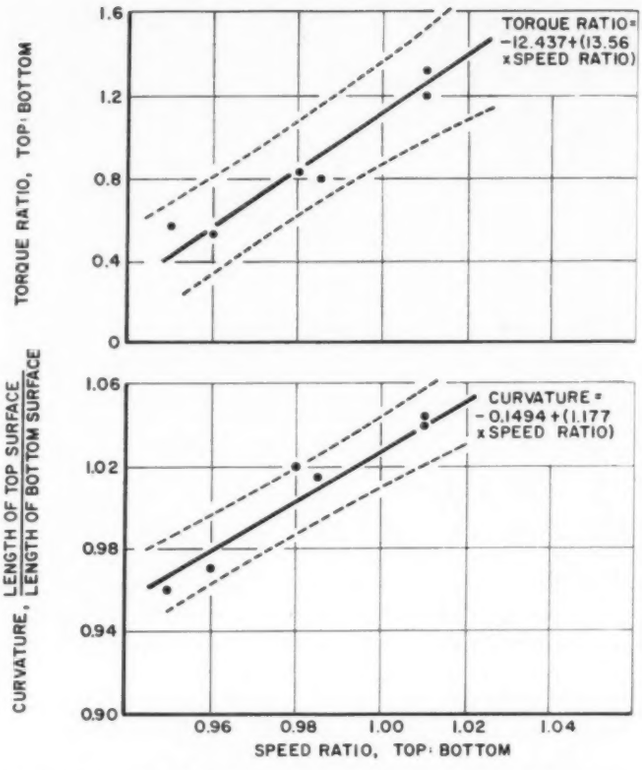

TORQUE RATIO, TOP : BOTTOM
TORQUE RATIO = -12.437 + (13.56 x SPEED RATIO)
CURVATURE, LENGTH OF TOP SURFACE / LENGTH OF BOTTOM SURFACE
CURVATURE = -0.1494 + (1.177 x SPEED RATIO)
SPEED RATIO, TOP : BOTTOM

Figure 9 — Empirical relations for curvature and torque ratios and speed ratios for symmetrical filled pass.

but in the center of the slab a severe upset occurred in which the top-roll speed decreased while the bottom-roll speed increased. At the same time, the top load current increased, while the bottom load current decreased. Therefore, the disturbance must have been a load change, probably because of a change, in slab conditions. The speed regulators effected a recovery in speed, but toward the end of the slab, the disturbance was repeated. The speed ratio for this run was 0.95, which for the conditions of the test should have produced a turned-up slab, as indicated by the region from 25 to 45 per cent of the sample length. The test conditions, together with the speed-ratio curve, indicated that the slab should have less turn-up at the head end because of the high head-end speed ratio; severe turn-up in the center because of the low-speed ratio; followed by slight turn-down because of the high-speed ratio; and finally near the tail end, more severe turn-up because of the low-speed ratio. The profile of the slab shows that the curvature corresponded to the expected variation. As mentioned before, this test was not a part of the balanced experiment, and disturbances such as these were not experienced with the descaled slabs. These examples illustrate the correlation between speed ratio and curvature for both transient and steady-state conditions.

An analysis of the results of the steady-state measurements showed that the observed effect of angle of entry on curvature was no greater than what could be attributed to experimental error. Therefore, angle of entry was not considered further as a variable. The remaining variables considered for their effect on curvature were three speed ratios, symmetrical and unsymmetrical passes, and filled and unfilled passes.

It was also found that the relationship of curvature to speed ratio could be expressed by four linear equations, each with a value for the constant and the slope (rate of change of curvature with speed ratio). In these equations, the value of curvature varied with the different conditions, but the variation of the slopes was no more than what could be attributed to experimental error. Consequently, the equations relating curvature to speed ratio could all be written with the same slope, but each with a different constant. Figures 8, 9, 10 and 11 show the graphs of the equations that represent the best estimate of the true relationship, and the region that may be expected to include the true relationship. The same procedure was used to derive the equations relating torque ratio to speed ratio.

In Figures 12 and 13, curvatures and torque ratios calculated from these equations are compared with the values measured in the experiment. The factors in the equations account for 92 per cent of the variation in curvature, and 86 per cent of the variation in torque ratio.

SUMMARY

For the simple hot-mill passes studied, the most significant factor affecting the amount of turn-up or turn-down of a piece of steel is the surface-speed ratio of the top and bottom rolls. However, if the pass design is truly symmetrical, such factors as the angle of entry and the amount of edge working required do not significantly alter the speed ratio needed to produce a straight piece.

A change in speed ratio will result in a corresponding change in curvature regardless of whether the speed ratio is changed by transient disturbances or by adjustment of speed settings.

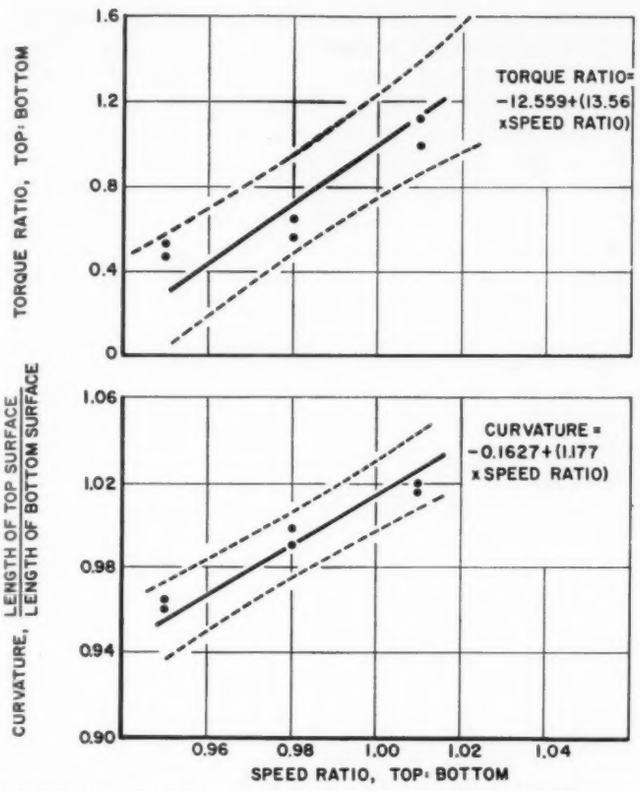

TORQUE RATIO, TOP: BOTTOM
TORQUE RATIO = -12.559+(13.56 x SPEED RATIO)
CURVATURE, LENGTH OF TOP SURFACE / LENGTH OF BOTTOM SURFACE
CURVATURE = -0.1627+(1.177 x SPEED RATIO)
SPEED RATIO, TOP: BOTTOM

Figure 10 — Empirical relations for curvature and torque ratios and speed ratios for unsymmetrical unfilled pass.

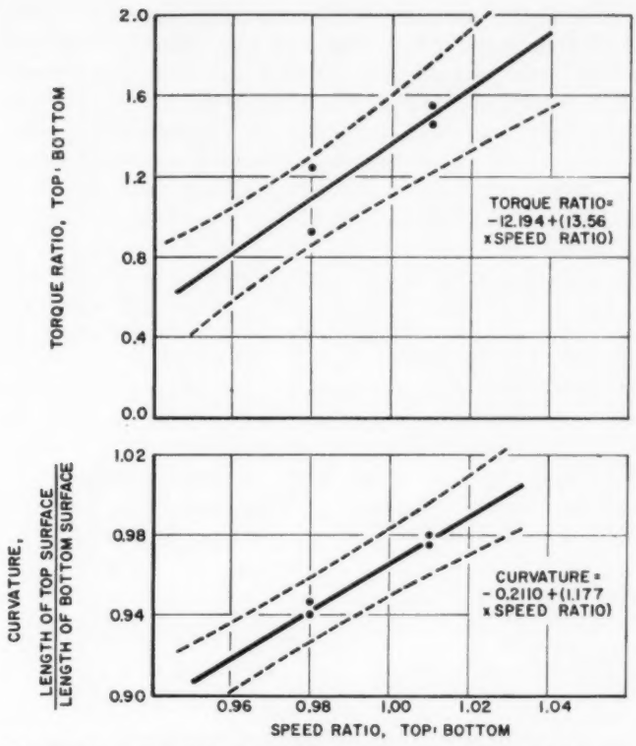

TORQUE RATIO, TOP: BOTTOM
TORQUE RATIO = -12.194+(13.56 x SPEED RATIO)
CURVATURE, LENGTH OF TOP SURFACE / LENGTH OF BOTTOM SURFACE
CURVATURE = -0.2110+(1.177 x SPEED RATIO)
SPEED RATIO, TOP: BOTTOM

Figure 11 — Empirical relations for curvature and torque ratios and speed ratios for unsymmetrical filled pass.

From the results obtained when a scaled piece was rolled (Figure 7), it was obvious that an "upset" condition approximately as severe as an entry condition can exist, and that loss of control of shape persists until the speed control has fully recovered. Thus, it may be concluded that proper descaling is necessary for a speed-controlled twin drive to be effective.

The experimental work showed that straight pieces can be delivered from a mill by a speed-controlled twin drive, but that even under the simplest controlled experimental conditions (equal roll diameters and an unfilled pass), the torque ratio between top and bottom rolls is not unity. Figures 8 through 11 show that the torque ratio is not adversely affected by the change in roll speed required to compensate for unlike roll diameters. The torque ratio, however, is greater when all edge working is confined to a single roll. Therefore, it may be possible through proper pass design and drafting practice to redistribute the torque requirements of the top and bottom rolls so that torque ratio may be maintained close to unity at the same time that speed ratio is controlled to minimize the amount of turn-up or turn-down. The relationship between the distribution of torque and the distribution of edge working between top and bottom rolls has been demonstrated for the simplified pass designs used in this study. However, it may not always be possible to apply the same principles to commercial structural pass designs and to still produce the desired finished section. Tests performed on a 32-in. mill at South Works indicate that drafting schedules may provide the necessary torque control for rolling shapes. When sheet-piling bars were rolled, the torque ratio top to bottom was 0.45, during the first reduction

Figure 12 — Curve shows that results checked quite closely with predicted values of curvature.

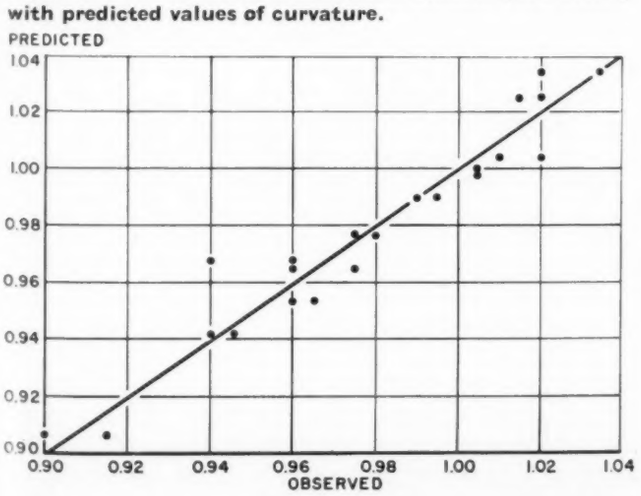
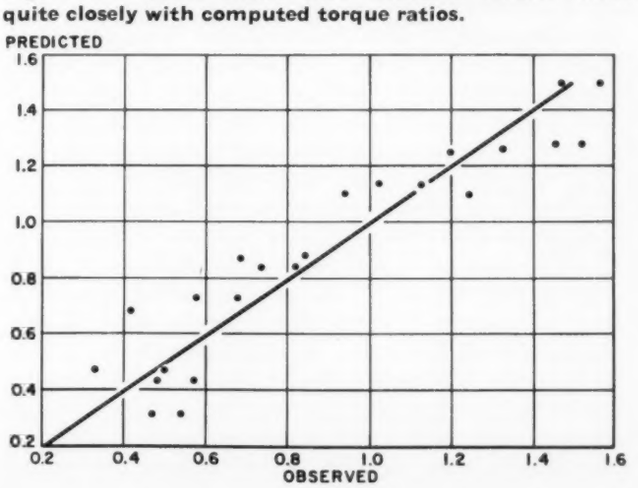


Figure 13 — Curve shows that measured results check quite closely with computed torque ratios.



in the first pass, and 1.67 during the second reduction in the same pass. These results show that for a given pass, the distribution of torque may be a function of pass opening and drafting. Therefore, it may be possible to schedule drafting in such a manner that the same total draft is obtained while acceptable torque ratios are maintained.

The characteristics of the roll-drive and the roll-speed control systems are very important if speed ratio is to be used to control curvature. Speed ratio must be controlled to a high degree of accuracy during acceleration and steady-state conditions because of the small changes in speed ratio required to effect a significant change in shape. In addition, transient speed drop and recovery time must be kept low to minimize the effect of speed-ratio variations during the load disturbances that always occur as the piece enters the mill and that may occur during rolling because of variations in scale conditions or other factors.

Discussion

PRESENTED BY

A. W. SMITH, Steel Mill Engineer, Metal Working Section, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

H. N. SNIVELY, Steel Mill Engineering, Systems Application Engineering Section, General Electric Co., Schenectady, N. Y.

LOUIS MOSES, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.

G. E. KENNEDY, Technologist, Applied Research Laboratory, United States Steel Corp., Pittsburgh, Pa.

F. SLAMAR, Research Engineer, Applied Research Laboratory, United States Steel Corp., Pittsburgh, Pa.

A. W. Smith: The tests, which must have represented many weeks of hard work, will probably lead to a better understanding of the problem of slab turn-down on slabbing or blooming mills.

On slabbing and blooming mills the turn-down of the steel is very undesirable since it causes pounding on the delivery tables and excessive maintenance on the table girders.

We have conducted tests to determine what can be done to eliminate slab turn-down. Adjusting the motor field current on a twin drive to give about one rpm higher speed on the lower roll made no visible improvement. Introducing a large unbalance in loads had no effect since the head end of the slab was through the mill before the load unbalance could be created.

The only method which gave improvement was to introduce a voltage difference between the upper and lower twin drive motor before the steel entered the rolls. With 4.3 per cent higher voltage on the lower motor, the load peaks were 30 per cent higher on the lower motor as compared to the upper motor and the slab turn-down was improved. With 7.15 per cent higher voltage the load peaks were 55 per cent higher and the slab was delivered straight from the mill. During edging passes, the slab was curled upward to form rockers, but this could be easily eliminated with an interlock on the screw-down to eliminate the bus voltage difference when the roll openings are large enough to no longer have the turn-down problem, say 8 in.

With this unbalance in voltage of 7.15 per cent, the lower motor thermal load was 30 per cent higher than the upper motor load. This difference in thermal load could be reduced if the voltage difference were eliminated as soon as the head end of the slab leaves the rolls. This would be in about a second or two.

I would like to ask the authors two questions. With a high gain load balance system as is used on twin drives for slabbing and blooming mills, do they feel that the angle at which the slab enters the mill has any effect on how the slab is delivered? It has been the feeling of some that the slab turn-down was worse on high-lift mills where the barrel part of the roll had to be carried higher off the tables than on a universal mill.

I would also like to ask the authors if they believe that, in the future, we would be able to predict loading of mills of this type to the extent of making up a twin-drive, 12,000-hp motor by using 4000 hp on the upper roll and two 4000-hp armatures on the lower roll with some special speed-load regulator, which would eliminate the turn-down and still get some desirable balance between the upper and lower load.

H. N. Snively: The authors have thrown new light on one ghost—angle of entry—and at the same time they have introduced a new concept in rolling nonsymmetrical shapes by use of controlled speed ratio with twin drive mills. I believe the industry owes these gentlemen, and the United States Steel Corp., a vote of thanks for making these tests, correlating the results, and producing empirical relationships between speed and torque ratios for various conditions of rolling. The mathematics surrounding the plastic deformation of steel is complicated and intermingled with theories and effects so that it becomes necessary to substantiate these concepts with controlled experiments. Needless to say, only in a very complete laboratory, with a furnace, a twin-drive mill and a group of fine electrical and mechanical engineers, could data of this type be obtained.

Manufacturers of electrical equipment cannot make significant engineering contributions to main roll drives without a steady flow of information coming back from the industry. We must remember that the answers we get from our analog computers are no better than the equations we feed into them. In many cases these equations must be empirical in nature, derived from carefully controlled tests.

I believe this is the true significance of the findings of U. S. Steel presented here today.

As the result of a brief study made by members of our section several years ago, control for our modern twin drive mills includes no-load speed unbalance by voltage control. A short time delay after the metal has hit the rolls, the voltage unbalance is removed and load balance becomes effective. This short time is sufficient to obtain a slight turn-up on the front of the slab giving a desirable ski-shaped appearance to the slab. We believe that for blooming, slabbing and roughing mills, this represents the optimum compromise which can be made.

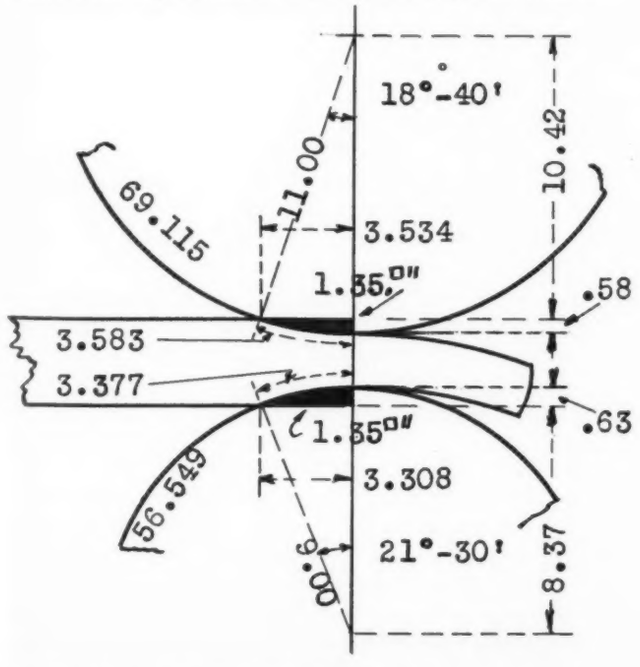
It appears that the principal factor causing symmetrical shapes, such as slabs and blooms, to turn down is the uneven temperature gradient through the section.

Thus the yield stress on the bottom, or cooler side of the slab, would be somewhat higher than that on the warmer side. Therefore, assuming top and bottom rolls were the same diameter, and slab is thoroughly descaled, if the same torque were applied to both rolls, we would expect the slab to turn down. The impact effect of the no-load speed unbalance, with the bottom roll turning faster than the top roll, is sufficient to give the slight turn-up on the front of the slab. The rebalancing of load undoubtedly causes the slab to bear down on the delivery table rolls nearest the mill. However, the thickness of the slab is great enough to prevent bending and to all appearances the slab is being delivered straight on the rolls. If it were desirable to eliminate the bearing down effect, it could be done by regulated speed ratio between top and bottom rolls. However, from torque tests made on pinion stand drives, the torque ratio between rolls could be as high as two or three to one. Such unbalance would require considerably oversize motors. For this reason, we believe for symmetrical shapes that load balance, and heavy table rolls, is the most economical compromise.

However, for nonsymmetrical shapes and closed pass rolling, it appears that regulated speed ratio gives the roll designer another parameter to work with. At present he can only apportion the shape between the two rolls in accordance with his design rules and experience to get straight delivery, and rely on heavy stripper guides to keep from cobbling. With twin drive arrangement and adjustable regulated speed ratio, he can now attempt to design a pass that can be rolled with one roll turning slightly faster than the other in such a relationship that the product should deliver straight and load ratio will be close to unity.

Louis Moses: A long step forward is taken with this paper in defining bar actions and torques occurring on rolling mills. The authors are congratulated on their thoroughness, their opportunity of doing such work and their company on providing the means. Analogies based upon operations and some speculation out of observations are offered in comment, some of this raising further questions because of apparently conflicting deductions, all a necessary part of research.

Figure 14 — With equal area segments at both rolls, the longer circumference of the top roll creates more elongation at the top surface of the bar, causing turn-down.



The differentials in power inputs, under the selected conditions of the paper, are revealing but not surprising. Subsequent to the presentation an analysis is made of the probable bar action when emerging from rolls arbitrarily assumed to be at dissimilar diameters. The sketch Figure 14, is predicated upon equal amounts of reduction performed by each roll in terms of calculated equal-area segments formed by the opposing arcs of contact. This positions the bar in the roll gap at an off-center position. The bar delivered by one revolution of the top roll is thus shown to be 69.11 x 1.35 = 93.30 sq in. (viewed in elevation along the direction of rolling). This is compared to the bottom roll factors of 56.55 x the same 1.35 = 76.34 sq in. The effects of elongation which produce more bar length than roll circumference are ignored.

The greater amount of elongation induced by the larger circumference of the top roll pushes the top surface particles ahead of those in the bottom surface and causes a turn-down. The longer arc of contact, plus the additional rates of shear, provide the reason for the reported differentials of torque at each spindle as well as explaining the relatively increased power noted to be more than the equal-diameter conditions.

Three-high plate mills are notoriously subject to turn-up, when drafting is not carefully applied. Typical roll diameters are 44½ in. top-bottom and 27-in. middles for a 160-in. mill; a 110-in. mill uses 38-in. and 24-in. rolls. The bottom passes have the small roll in the upper position, the larger roll in the bottom. Narrow plates on a 160-in. mill are particularly subject to turn-up when reduced to about 2½ in. thickness. At this point of reduction the drafting becomes critical, not varying from long-established limits. Otherwise, with no stripper guide at the smaller, upper, roll the emerging plate will curl upward to 180 degrees of curvature and attempt to continue to coil. However, on such infrequent misapplied draftings, the upturned end, in doubling back, strikes the rest-bar of the top pass immediately above and cobbles. Serious as such an instance can become, there is a rare case when the height of the curved end over-reached the rest-bar, entered the top pass and caused considerable damage.

Accidentally misapplied drafting to a bottom pass also produces turn-ups when plates arrive at the region of ¾ to 1¼ in. thickness. Such turn-ups are the "sleigh runner" variety which go sailing down the table at over-all heights of 3 to 5 ft, 2 to 3-ft radius, sometimes with more than 200 degrees of curvature. Taken more or less in stride there is no alarm or damage except when they buckle, becoming liable to form double thickness when entering the next pass. Under the creating influences in the roll gap it is assumed that the weight of the curved end prevents a virtual coiling.

Opportunity has been taken to measure the cobbles from the very rare instances of stalled mills. Longer arcs of contact were determined as being formed by the larger roll. Conclusions are that the entering plate is not centered in the roll gap, that equal segmental areas occur at opposing arcs of contact, that the longer arcs of contact cause plates to turn up, and that possibly

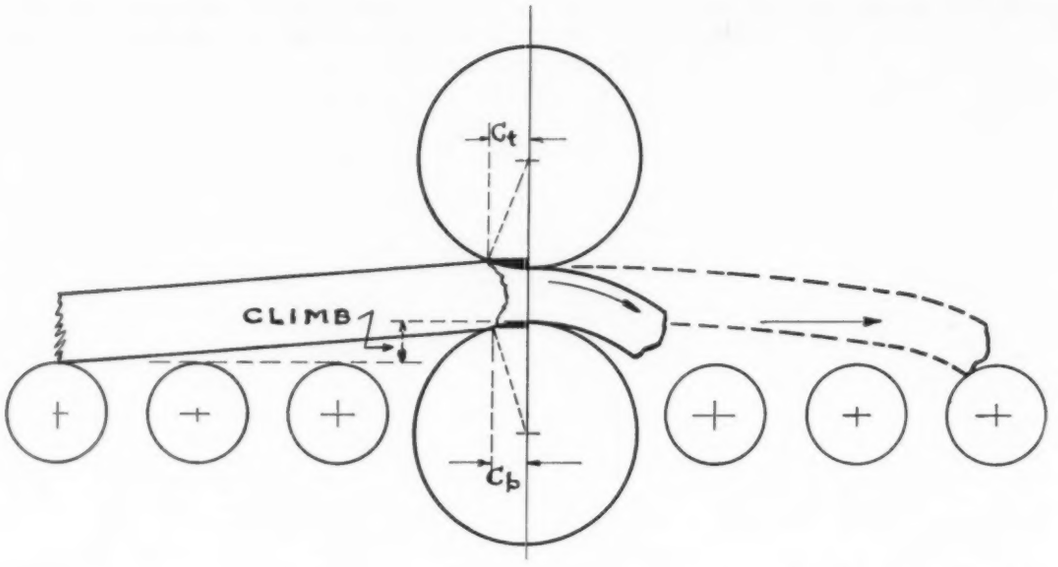


Figure 15 — Climbing of slab end probably produces greatest segment area on top roll, producing turn-downs.

some amount of inbalance between opposing arcs of contact cannot be exceeded without causing turn-ups.

Turn-down influences also operate in the top pass. However the stripper guide on the smaller roll receives the plate and runs it out without curled ends.

A correctly executed pitching of structural channel passes on three-high mills balances web and flange work. The resultant diameters of the rolls forming the web appear to vary considerably. Improper pitching illustrates the grievious effects of one roll pulling the others along. When the last inch of the back end of a rolled length of channel is released from such a set of "wound-up" rolls, a severe back-lash occurs, just as would happen to the author's rolls if in production. Instances have broken spindles, boxes, roll wobblers and, in one case, the crab of the drive.

Literature is limited on the power requirements of side work, aside from Prof. Trink's treatment on reductions performed against side walls and between flange-forming grooves. Most of the recent studies, Underwood, etc., are confined to reductions between plain bodied rolls. There have been instances when a roll designer changed to other types of grooves, diagonal vs former box passes, the use of the hard pulling "hat pass," etc., finding the mill drive to be inadequate. Sure, most of this is past history, requirements can be compared with modern methods, we say, but such situations can happen again. The power data on the industry's mills is not sufficient to draw comparisons on the power required for given areas of reduction in varying kinds of roll gaps, structural, piling, etc. As indicated by the authors such increased knowledge would be highly rewarding and valuable.

Experienced mill men agree that upward inclined bar entry into rolls of substantially the same diameters creates downward emergence. Such conditions are readily controlled by guides on merchant, and the larger mills which are served with traveling tables. Consideration on this turn-down tendency is extended to high lift blooming mills where the relative levels of edging-groove bottoms and the higher elevation of the bullhead creates "climbing" of the slab. The bottom of the edging groove is positioned at such a height above the table rollers as to be barely sufficient to handle the imposed amounts of drafting. The resultant approximately 3 in. of climb is contrasted to the 1¾-in. climb on slabbing mills which causes little difficulty with turn-downs. It has been stated that the best operating condition, granted the drafting schedules permit, is 1¼ in. of climb.

Very considerable experimentation has been made on twin drive mills by varying the respective roll speeds, usually by speeding up the bottom roll, in attempt to remedy turn-down by inducing some degree of turn-up. So far as known, no definite conclusions are drawn that this is a satisfactory correction. One source states that a very considerable speeding up of the bottom roll is required to produce any noticeable change. Under this condition the total power of the twin drive is reduced. Another doubts that the electrical tie-in of the two motors is as positive as a pinion drive and that the difficulty has been present only during the period required to properly adjust all the controls. The over-all opinion is gathered that the greater elongation at the bottom face of the slabs, as sought to be induced by the faster moving bottom roll, does not turn up the slab ends. This is apparently in contradiction to the foregoing deductions on bars and plates. A distinction may be made between the speed differentials of nearly equal roll diameters and the variances in lengths of contacts arcs of dissimilar diameter rolls. It could well be that the surface plasticity of thick slabs can absorb the speed differentials and not penetrate deeply into the mass, whereas the effects of longer arcs of contact, applied to relatively thinner bars, does cause turn-up and turn-down.

The operators of these and future similar mills certainly need to know the actual reasons for slab turn-down. A concept of the cause is offered here for consideration. On Figure 15 it will be noted that a greater segmental area represents more reduction of metal at the upper corner of the slab, compared to a lesser reduction at the bottom corner. The relatively greater elongation of the longer, top, arc of contact, possibly buttressed by the inclination, starts a bend at the entering end of the slab. This bending continues for a short distance around the smaller arc of contact of the bottom roll. Whatever the length of the end portion (partially through the rolls) may be, it is sufficient to form a hook or turn-down. This discounts the entering front-end portion of the slab immediately bowing into

an approximately horizontal position. A nearly level position might be assumed after more length goes through, the weight of the emerging side balancing the entering side. Within the ability of our visual perception, the slab appears to climb up the roll face and to be bent down on the exit side like a piece of pliable rubber. The effect is a downward, hooked, end which jams into every roller on the table.

However, this concept disregards the condition that a balanced amount of reduction must be present. How can more reduction occur at the top and less on the bottom roll? Can such a condition occur for only a short period of time after which the reductions on each slab face become equalized? Is the suggestion in order that slow motion pictures, or the stroboscope, be applied in searching for the actual cause of this reportedly serious operating condition?

Our old art of rolling is applied to current grades and trade demands. It must be applied to the newer metallurgical products. Consideration of both requires study and trials to secure maximum quality, so far as may be conferred by rolling. Economies in production will go hand in hand.

G. E. Kennedy and F. Slamar: We appreciate the comments submitted, which indicate further that considerable work remains to obtain a better understanding of turn-up and turn-down. Although this paper presents a method for controlling such curvature, no effort was made to suggest how this could be done while maintaining acceptable torque ratios. It is hoped that future work, especially in roll pass design, will provide information along these lines.

The effect of angle of entry on curvature with a high-gain load balance system was not a part of the experiment, so that no conclusions can be made here concerning this effect. It is difficult to predict whether future mills will have motors of unequal ratings, because much more about the causes of turn-up and turn-down will have to be known before such a major change in mill design would be made. ▲

Tube Mill Practice

A selection of articles from the IRON AND STEEL ENGINEER on various phases of tubemaking.

(Published in 1953)

Practical information on layout and operation of facilities for seamless, butt and electric weld pipe, a field in which little information has been published...23 articles by 20 authoritative writers ...invaluable for engineers, operators, trainees and students.

$8^1/_4$ x $11^1/_4$ in.....196 pages, illustrated, clothbound

Price: To AISE Members...$2.00

To Others.....$4.00

ASSOCIATION OF IRON AND STEEL ENGINEERS

1010 Empire Building

Pittsburgh 22, Pa.

AISE DISTRICT CHAIRMEN 1957-1958

R. L. FELLERS was graduated from the University of Cincinnati with a degree in electrical engineering and began his steel mill career in the Andrews Steel Co., where he worked for 12 years, rising to chief electrical engineer. He then worked for $3\frac{1}{2}$ years in Oak Ridge, leaving to join the National Tube Division of the United States Steel Corp. as general supervisor of design engineering. After eight years here, he transferred to the Tennessee Coal and Iron Division as chief development engineer, his present post.

F. R. FIELDING, a native of Sharon, Pa., was graduated from Penn State in Mechanical Engineering in 1916. He went to work at the Donora Steel Works of the American Steel and Wire Co., working in various departments until 1921 when he was employed in the engineering department of the Donner Steel Co. in Buffalo, N. Y., which company later combined with others in the forming of Republic Steel Corp. After serving as field engineer in this plant, he was appointed assistant chief engineer in 1945, and district chief engineer in 1952. He now serves in that capacity.

ROBERT A. KRAUS, a native of Chicago, obtained bachelor and master degrees in mechanical engineering at the Illinois Institute of Technology. In 1939 he entered the steel industry, joining the Republic Steel Corp. in Chicago as a junior mechanical engineer, moving up later to an industrial engineer. In 1943 he was appointed lubrication engineer, and in this capacity assisted in the construction of the Republic Chicago Defense Plant. In 1947 he was named to the position of general mechanical foreman for the Chicago plant, was later named assistant maintenance superintendent and in 1957 was appointed superintendent of mechanical maintenance, in which capacity he now serves.

F. M. DARNER, a native of Ohio, was graduated from Case Institute of Technology in 1922 with a bachelor of science degree in mechanical engineering. He entered the steel industry that year with the Armco Steel Co. at Zanesville, Ohio, as testing engineer and liaison for the Middletown Engineering Department in the Zanesville plant. In 1923 he moved to Armco, Middletown, Ohio, as a member of the sales development group. In 1926 he entered the engineering department of the Erie Steam Shovel Co., Erie, Pa. In 1927 he was employed by Erie Malleable Iron Co. as plant engineer in charge of all service shops and equipment. In 1933 he entered the employ of the Republic Steel Corp., steel and tubes Cleveland, plant, as plant engineer, in 1934 became chief engineer of this division in 1939 he was promoted to assistant chief engineer of the corporation and in 1942 was named chief engineer, manufacturing divisions. He now serves in this capacity as well as being appointed in 1950, upon organization of Reserve Mining Co. for taconite beneficiation, as supervising engineer, in charge of design engineering.

A. D. SHATTUCK entered the steel industry in 1933 being employed at the Central Alloy District of Republic Steel Corp. at Massillon, as heater helper. He joined the Great Lakes Steel Corp. in 1938 as coke oven battery foreman, advancing to general turn foreman, to assistant superintendent and in May 1951 was appointed superintendent of coke plant, the position he now holds.

RUBEN FINKELSTEIN, a native of Los Angeles, entered the scrap iron and steel business in 1917. He is now vice president of Finkelstein Supply Corp., one of the leading scrap yards on the coast. In 1940 the Southwest Steel Rolling Mills was incorporated, with Mr. Finkelstein as vice president.

M. B. ANTRIM, a native of Pennsylvania, received an electric engineering degree from Rensselaer Polytechnic Institute in 1939. He was first employed by Westinghouse Electric Corp. in Philadelphia before joining Lukens Steel Co. as assistant to the superintendent, electric, in 1941. At Lukens he has progressed successively from senior technical assistant, electrical engineer, assistant superintendent and superintendent of the electrical department. Since 1953 he was appointed to assistant manager of the maintenance and construction division, which position he now holds.

R. T. LUCAS, was born in Steubenville, Ohio. He attended elementary and high schools in Steubenville, and attended Cornell University, graduating in 1930. He first entered Weirton Steel Co.'s employ as substationl operator in 1933, and after successive promotions became electrica superintendent of that company in 1951, the position he now holds.

GEORGE M. HARVEY began his career working for a short time for an electrical constructor. In 1917 he joined Laclede Steel as an electrician helper. In 1925 he was named assistant chief electrician, in 1942 he was appointed chief electrician and in 1947 was appointed electrical superintendent of all Laclede plants and warehouses in which capacity he presently serves.

W. H. KINNEY was graduated from the University of Arizona with a bachelor of science degree in metallurgical engineering. From 1943 to 1947 was spent in the United States Army as Cavalry officer, serving in Europe. In 1948 he joined the Kaiser Steel Corp. at Fontana, Calif., first as a metallurgical assistant, then metallurgist, and in 1950 he became a metallurgical engineer. From 1956 to the present time he has been assistant to vice president in charge of operations at Oakland, Calif.

W. E. HARRIS is a native Californian, and was graduated from the University of California at Berkeley with a bachelor of science degree in industrial engineering. In 1949 he was employed with Consolidated Western Steel Division Berkeley plant serving in the following positions: material expeditor in the production department, assistant foreman in the erection department, scheduler in the production planning department, design draftsman and project engineer and plant engineer. In 1953 he was assigned to the designing and planning of the construction of the Utah Pipe Mill, and in March, 1955 he moved to Provo, Utah, to assume his present duties as plant engineer of the pipe mill.

M. J. BURGER, a native Pennsylvanian, was graduated from Georgia Institute of Technology with a bachelor of science degree in electrical engineering in 1940. He joined the United States Steel Corp. as draftsman in the Ordnance Engineering Division, Pittsburgh, transferring to Mingo Junction as electrical construction supervisor. In 1943 he was transferred to the Youngstown District as design engineer and was promoted to assistant electrical engineer in 1947. In 1948, he was appointed to his present position as general supervisor, electrical engineering.

R. L. FELLERS
Birmingham District Section

F. R. FIELDING
Buffalo District Section

ROBERT A. KRAUS
Chicago District Section

F. M. DARNER
Cleveland District Section

A. D. SHATTUCK
Detroit District Section

RUBEN FINKELSTEIN
Los Angeles District Section

M. B. ANTRIM
Philadelphia District Section

R. T. LUCAS
Pittsburgh District Section

GEORGE M. HARVEY
St. Louis District Section

W. H. KINNEY
San Francisco District Section

W. E. HARRIS
Utah District Section

M. J. BURGER
Youngstown District Section

The large automatic contour roll lathes are relatively new in the roll shop . . . . some four are in use, some four are being built, and several others are being considered . . . . in the future a great deal of roll turning work will probably be handled in these units.

Automatic Contour Turning of

by WILLIAM HYAMS
Manager of Machinery Sales
Mackintosh-Hemphill Div.,
E. W. Bliss Co.
Pittsburgh, Pa.

THE remarkable postwar expansion of the American steel industry has affected everyone from company president to unskilled laborer in one way or another. Very often, where production methods have been based on traditional concepts and practices, this expansion has not been entirely free of "growing pains."

The preparation and redressing of mill rolls is one of these areas steeped in tradition. Since the earliest days of rolling mills, their rolls have been readied for use with hand tools in block lathes. Even today, block lathes operated by skilled roll turners still account for somewhere above 90 per cent of the turning capacity of the steel industry's roll shops.

With no implied criticism of block lathes—which are indispensable and are likely to remain so for many operations, especially finishing—the writer maintains that the time has come when roll shops must supplement their block lathe capacity with faster and more productive turning techniques.

For example, the mill additions and modernizations completed since 1945 have increased the roll turning burden by roughly 50 per cent. In contrast to this tremendous increase in roll finishing requirements, there have been few extensive additions to roll shop capacity.

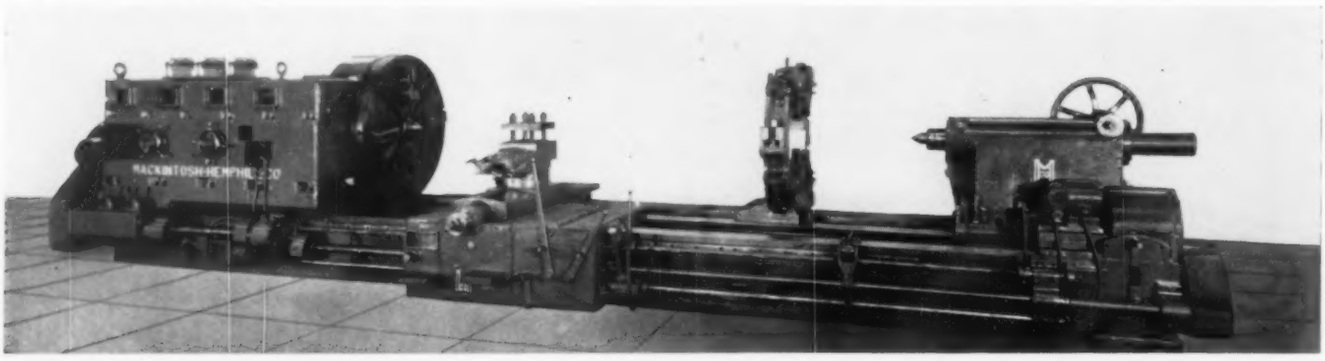
One answer to the problem has been to add small or medium-sized contour lathes to increase turning capacity for smaller rolls, while putting existing block lathes on an 18-to-20 turn-per-week schedule. This would suffice, perhaps, if it were not for another complication, this is, simply that the supply of skilled roll turners is no longer adequate. Each year sees more retired roll turners than new apprentices to replace them.

Even under above-average skilled labor supply conditions, keeping today's heavily-scheduled mills provided with rolls—and especially with the larger rolls—is not easy. Turning or redressing of large blooming or slabbing mill rolls is a time-consuming process. As received at the mill from a roll foundry, a typical 44- x 110-in. blooming mill roll will have between ½- and 1-in. stock on its radius. Depending on the section to be produced, each roll may require from 50 to 70 man-hours to finish from the rough in a conventional block lathe, or 100 to 140 man-hours per set.

After normal use in the mill, this same pair of blooming mill rolls must be redressed, requiring perhaps 50 block lathe man-hours per pair for removal of about $\frac{5}{16}$-in. metal from the radius.

These figures will vary widely from one roll shop to another, since lathe time is a function of block lathe condition, turning practice and operator productivity. In general, however, block lathe time required for turning a given set of rolls has not been appreciably reduced over the mill expansion years.

Figure 1 — This 72-in. × 30-ft centers heavy duty three-bedway engine lathe was built in 1941. Long and cross tool feeds are powered from spindle drive.



Large Mill Rolls

To effect savings, roll shop management, supervision and engineering in many cases have developed within their own plants roll turning improvements such as hydraulic tool-pushing devices, regearing and speeding-up of existing block lathes and, occasionally, application to these faster block lathes of separate contouring equipments. By approaching the lathe builders, roll shop management has also supplied an impetus toward improved new roll turning lathes and tooling, and toward development of better and larger automatic contouring lathes.

Because we supply to steel mills many thousands of tons per year of all types of cast rolls, our company has always been more than ordinarily interested in the lathe as a roll turning tool. Most of our rolls are finished on both necks. Some are fully finished on the body, others are partly finished or rough finished. The result is a heavy volume of turning which requires maximum utilization of equipment including roll lathes in meeting delivery dates.

This continuing basic interest in roll turning lathes was augmented during World War II when our company designed and built some fifty large extra-heavy-duty lathes for machining gun and ship shaft forgings. Figure 1 shows a 72-in. heavy-duty engine lathe.

The manufacture of these big lathes had been preceded and was followed by designing and building somewhat similar heavy-duty lathes adapted particularly to the machining of our own rolls, with emphasis on flat or cylindrical body types used in strip and plate mills. See Figure 2, a 44-in. screw-feed roll lathe.

Four of these screw-feed roll lathes, each of which have two tool carriages equipped with power long- and cross-feed, are in use in our roll-machine shop in Pittsburgh; mostly on hard iron rolls. Another lathe of the same type, except that one carriage will have automatic contouring equipment, will soon be in service here.

As long ago as 1949, when the first small and medium-sized automatic roll contouring lathes were appearing on the market, we were conducting experiments in turning large shape rolls on one of these 44-in. screw-feed roll lathes equipped with an electronically-controlled tracing apparatus. A single-direction duplicator was used, in a rather unique way which provided dual duplicator results. These experiments, so far as we know, marked the first use of fully-automatic contouring equipment in the turning of large rolls. Figure 3 shows experimental duplicator on 44-in. screw-feed roll lathe.

The operation of this experimental setup was studied by the roll shop personnel of several steel companies.

60-IN. HEAVY DUTY ROLL CONTOURING LATHES

The first automatic contouring lathes built by us were 60-in. x 18 ft 0 in.-machines; one was ordered by United States Steel Corp. for its Homestead Works at Munhall, Pa., the other by Jones & Laughlin for its South Side Pittsburgh plant. Some of the interesting features of these lathes, developed through design cooperation with our customers' roll shop personnel are: hardened and ground liners on bedways and under cross slide, built-in fully-automatic contouring equipment, heavy-duty adjustable roll housings, live-center tailstock, desirable cutting speeds and feeds, centralized control grouping on the carriage, etc. Figures 4 and 5 show 60-in. automatic contour lathes.

Basically, these first 60-in. roll contouring lathes are single-carriage screw-feed machines with general specifications somewhat similar to the 60-in. currently-applicable specifications tabulated in Table I. For comparison purposes, general specifications of a recent 48-in. contouring lathe are also tabulated.

Figure 2 — A 44-in. × 21-ft centers heavy duty screw-feed roll turning lathe with two tool carriages. Long and cross tool feeds are powered from spindle drive.

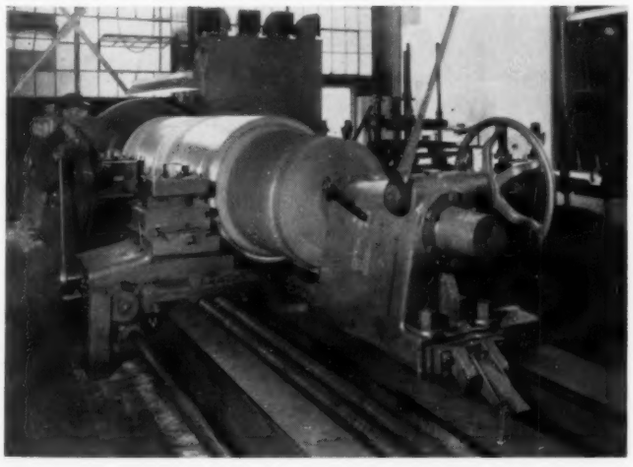
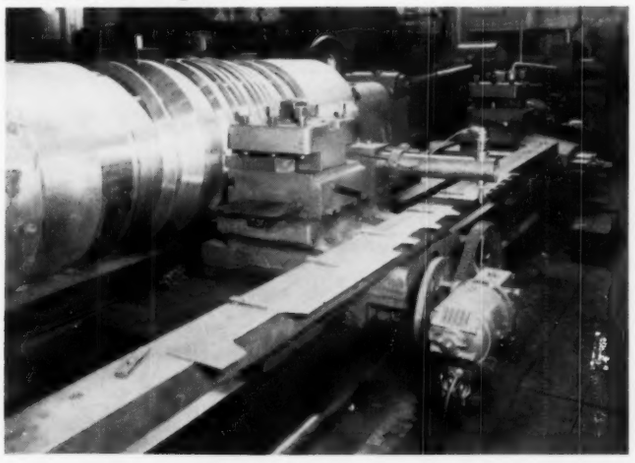


Figure 3 — This 44-in. screw-feed roll lathe has experimental automatic contouring equipment. Cross feed duplicator motor is shown mounted on tool carriage. Similar motor drives long feed.



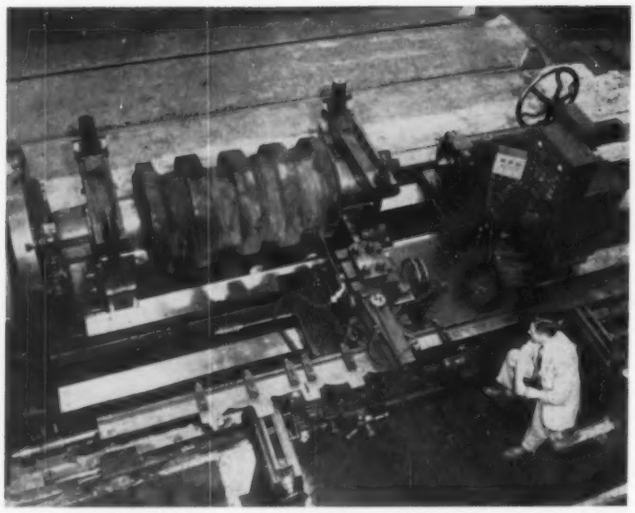


Figure 4 — A 60-in. × 20-ft centers automatic contouring roll lathe has 28–32-in. mill roughing roll for 8- × 4-in. angles, mounted in neck rests. Roll body is 30-in. diameter × 58-in. long; cast steel, hardness about 36 scleroscope.

TABLE I

Typical 60- and 48-in. Automatic Contouring Roll Lathes Principal Dimensions and Specifications

	60-in.	48-in.
Bed		
Length	For 25-ft centers, 42 ft-0 in.	For 18-ft centers, 32 ft-0 in.
Length overall, including meter and chip pit	60 ft-0 in.	50 ft-6 in.
Width across top	5 ft-5 in.	5 ft-5 in.
Depth	2 ft-0 in.	1 ft-6 in.
Swing		
Over ways (diam), in.	68	52
Over carriage (diam), in.	60	48
Headstock		
Live spindle diameter, in.	12	12
Change gears	Double helical	Double helical
All other gearing	Double helical	Double helical
Faceplate		
Diameter, in.	60	52
Range of speed, rpm	0.67 to 62	0.67 to 62
Carriage		
Length on bed, in.	71	68
Tailstock		
Length on bed, in.	64	44
Width on bed, in.	31	31
Spindle travel, in.	12	10
Live center quill diam, in.	14½	12
Range of feeds		
Longitudinal, in. per min	0 to 3	0 to 3
Cross, in. per min	0 to 3	0 to 3
Main drive motor	125/150 hp d-c 300/1200 rpm constant hp 50/300 rpm constant torque	100 hp d-c 300/1200 rpm constant hp 50/300 rpm constant torque
Longitudinal feed motor	3 hp d-c, electronic control	2 hp d-c, electronic control
Cross feed motor	3 hp d-c, electronic control	2 hp d-c, electronic control
Longitudinal rapid traverse motor	10 hp a-c	5 hp a-c

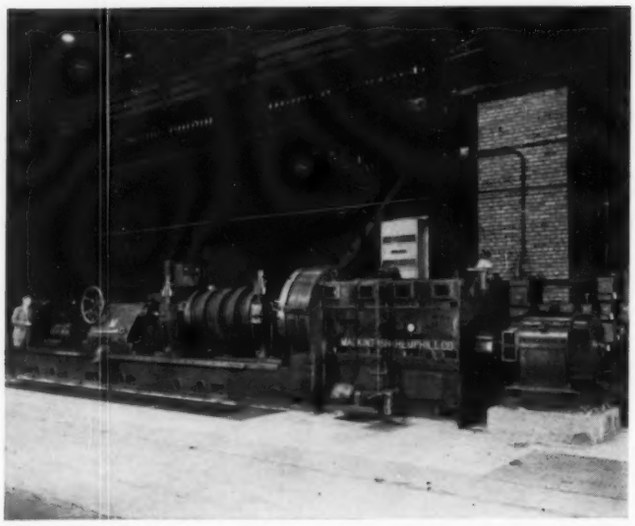


Figure 5—A 60-in. × 20-ft centers automatic contouring roll lathe. Chip conveyor access cover parallels bed in foreground.

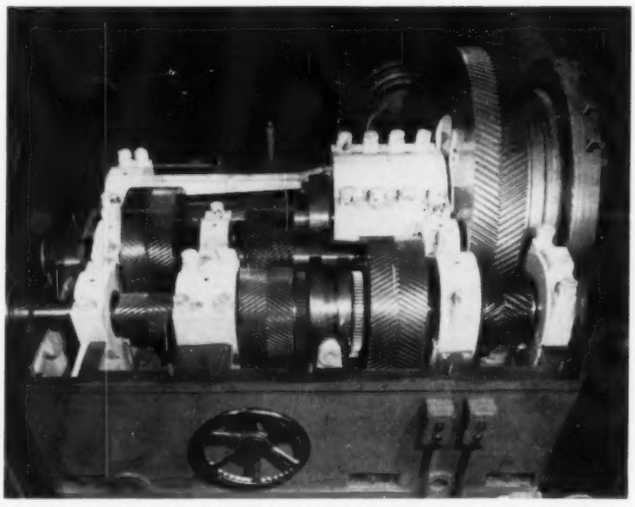


Figure 6 — Headstock spindle drive gearing for automatic contouring roll lathes. Double helical gears are used, with two spindles speed ranges by gear-clutch shift.

Figure 6 shows the double helical headstock drive gearing. As is generally known in the industry, one of these large automatic contouring roll lathes of nominal size 48-in. x 18-ft centers, equipped with electronic dual duplicator, has been in use for over a year in the main roll shop at Inland Steel Co.'s Indiana Harbor Works, East Chicago, Ind. A second lathe of size 60-in. x 25-ft centers with the same type duplicating equipment will soon be delivered to the new No. 4 Roll Shop of this same plant. Both of these lathes, as covered by general specifications previously listed, incorporate important design refinements over preceding machines. Through the courtesy of Inland Steel Co., Figures 7, 8, 9, 10, 11, and 12 have been obtained. These show the existing 48-in. machine in contouring or other turning operations on various types of rolls.

AUTOMATIC CONTOURING ROLL LATHE PERFORMANCE

Performance data typical of these 60-in. and 48-in. contouring roll lathes is naturally of maximum interest to steel plant personnel responsible for roll servicing be-

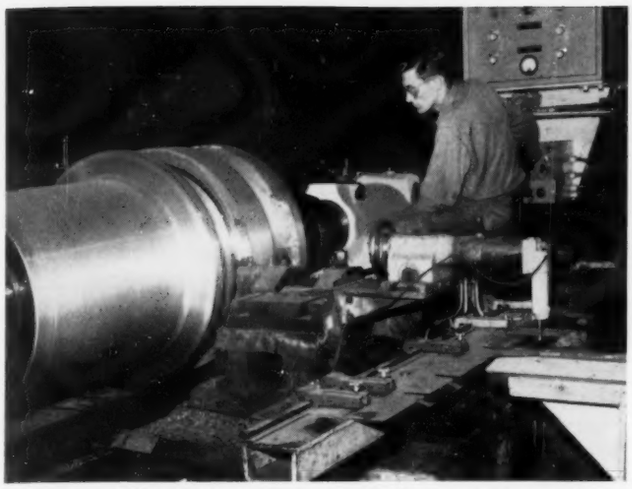


Figure 7 — This 48-in. contouring lathe is rough turning a 12-in. × 7½-in. beam roughing roll of 36½ in. pitch diameter. Roll is cast alloy steel of hardness 36 scleroscope.

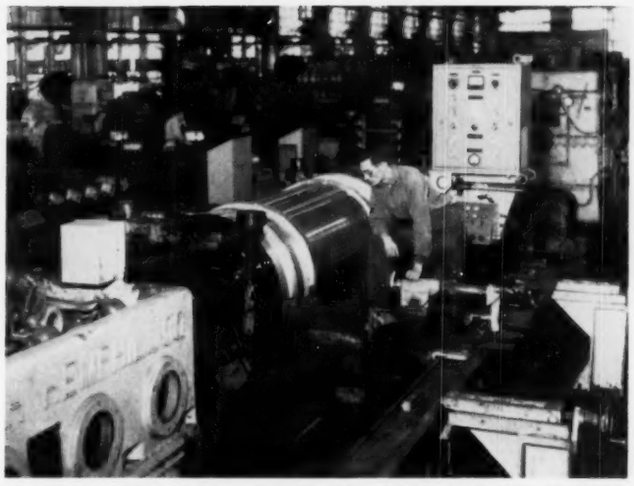


Figure 8 — This 48-in. contouring lathe is finish dressing a 46-in. blooming mill roll on neck rests. Roll is cast alloy steel of hardness 34 scleroscope.

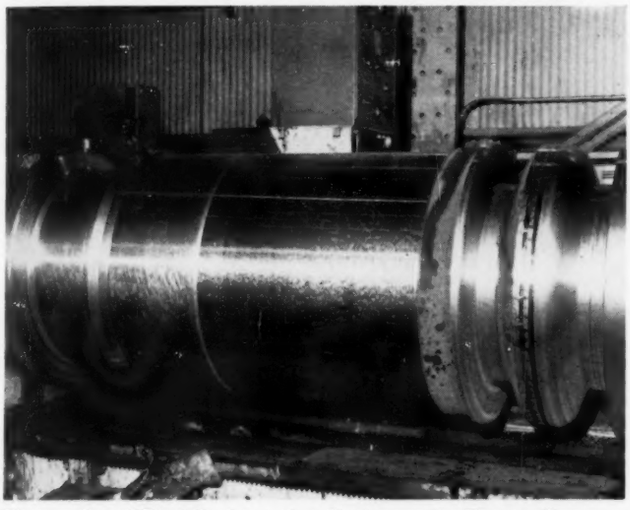


Figure 9 — "Back" view of roll shown in Figure 8.

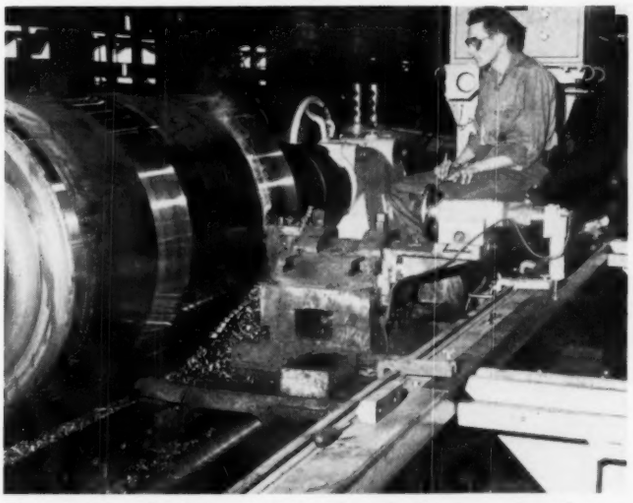


Figure 10 — A 48-in. contouring lathe is redressing a spalled 44-in. × 45-in. body hot strip mill backup roll of hardness about 50 scleroscope.

Figure 11 — Close-up of center-mounted tool holder for deep-groove contouring. V-bottom tool shank is changed to suit cut direction.

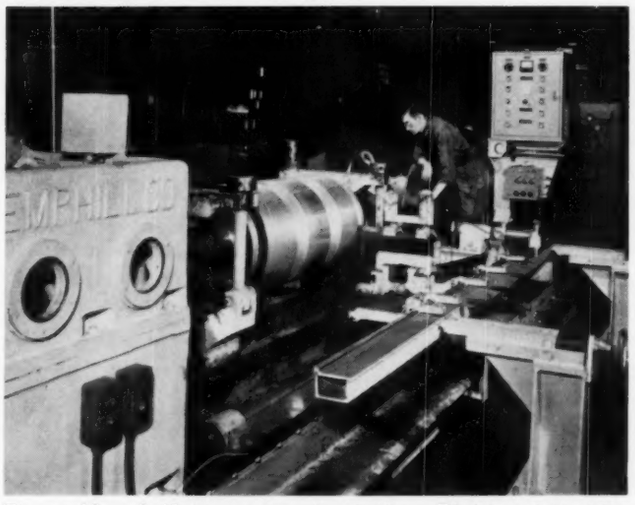


Figure 12 — A 48-in. contouring lathe. Right or left side-mounted tool holders are used for heavy cuts.

cause of the attractive man-hour savings shown to date by these machines as against block lathe man-hours for the same turning operation.

A tabulation of comparative times, contour lathe versus block lathe is, however, not within the scope of this paper because this information is the property of the lathe user and can be obtained only with the user's permission through normal channels.

For general evaluation purposes, however, the following typical contour lathe performances are cited; setup time varying between ½ hr to 4 hr depending on crane availability, is included unless otherwise noted.

Rough to full finish

1. 36-In. blooming mill roll—size 32 x 74 in. with wide slab pass and two box passes; ½-in. stock on body radius. Body finish-contoured from the rough in 9 hr.
2. 36-In. blooming mill roll—size 32 x 74 in., same as above, body finish-contoured from the rough in 6 hr.
3. 44-In. x 110-in. blooming mill roll furnished rough from the foundry with approximately 1-in. stock on body radius. Two cuts taken, total time 16 hr for body contouring.
4. 32-In. x 74-in. rolls for 36-in. blooming mill—4 special passes—foundry rough to finish—top roll 24 hr, bottom roll 22 hr, includes total 8-hr setup time for both rolls.
5. 28-In. x 62½-in. billet mill roll—7 passes—finish-contoured from the rough; 14 rolls; average time per roll 21 hr.

Rough to finish allowance (finish in block lathe)

1. 29-In. x 68-in. roll for 28-in. structural mill—12-in beam finisher—3 passes—foundry rough to 0.050 in. finish allowance. Top roll 15 hr. bottom roll 18 hr.

Contour redressing

1. 42-In. x 100-in. rolls for 46-in. blooming mill—2 box passes—redress 9/16 in. off radius. Top roll 15 hr bottom roll 10.3 hr (deep fire cracks difficult to dress out).
2. 28-In. x 62½-in. billet mill roll—7 passes—redress; 44 rolls, average time per roll 8½ hr.
3. 34-In. diam by 15-in. face vertical roll ring for wide flange beam mill, 44-in. structural mill—crowned roll face redressed, removing 1/16-in. stock or more on radius. Four rolls—average 2.9 hr per roll, including 1.1 hr per roll setup time.

Straight turning

1. Nominal 56 x 84-in. body length backup rolls for 4-high cold strip mill; 6 rolls as follows:
   54-In. OD reduced to 43-in. OD—61 hr.
   56-In. OD reduced to 43½-in. OD—68 hr.
   55¾-in. OD reduced to 43-in. OD—51 hr.
   53-In. OD reduced to 43-in. OD—59 hr.
   53⅝-in. OD reduced to 43-in. OD—59½ hr
   52¾-in. OD reduced to 43-in. OD—61 hr.
2. 49-In. diam x 42-in. cold mill backup rolls; originally 50 scleroscope, 6 rolls, each reduced 9 in. in diam—times per roll 52.1 hr, 52.1 hr, 45.1 hr, 67.8 hr, 34.0 hr, 33.9 hr.

Straight redressing

1. Eight 44-in. diam x 45-in. body length cold strip mill backup rolls, redressed 3/16 in. off body radius. Total time including setups, 19.4 hr. Average dressing time per roll, 1.6 hr. Average setup time per roll, 0.8 hr.

An interesting characteristic of these duplicating roll lathes is that the tailstock, equipped with a roller bearing live center of capacity up to about 40 tons or more, rides on the "back" bedway and part of the middle bedway, as do also the pair of roll housing supporting the roll. The tool carriage is of special design and is supported solidly by the front way and the remaining half of the middle way. This construction has two important advantages. First, it permits the carriage to travel the full length of the lathe when desired without interfering with the roll housings or the tailstock. The second advantage, important for heavy roughing work, is that the middle way supports the tool carriage in the area normally directly below the cutting tool, practically eliminating vertical spring and vibration. Due also to the three-way bed design, these lathes will accommodate rolls of approximately the same maximum diameter as the faceplate, because the tool carriage does not extend under the roll and therefore does not reduce the machine's diameter capacity. Figure 11 shows tool holder.

A typical tool post, mounted on the carriage cross slide is intentionally made narrow in width and with a long extension so that roll grooves, as deep in one case as 12 in. maximum, could be finished. This tool post is exceptionally rigid because it is heavily braced in a vertical direction, with solid bolted seat on the cross slide at its bottom. Its 2¼ in. width is necessarily unbraced sidewise over the area where the tool holder may penetrate into a deep pass; beyond this area it is satisfactorily braced, bolted and keyed to the cross slide. The upper part of a typical tool holder is machined with a V-groove seat to receive a heavy tool shank similarly V-shaped on the bottom. Tool shanks are made both right-hand and left-hand, to accommodate circular indexable button tools of diameters as needed and also to accept clamped-on rectangular indexable carbide inserts for straight cutting with manual control of feeds.

It has been observed that long and necessarily narrow tool holders, which are designed to enter deep passes and therefore cannot be fully braced in a sidewise direction, are subject to an occasionally noticeable amount of sidewise deflection, particularly when taking heavy roughing cuts. Deflection amounts varying between 0.012 and 0.016 in. have been noted under deep cut and heavy feed conditions, and an objectionable end effect of such sidewise tool post deflection is that, if the tool feed is stopped when cutting down the side of a steep collar, while roll rotation is allowed to continue, an annular groove will be turned by the tool in the side of the collar to a depth equal to working deflection of the tool post. For this reason, roughing cuts using heavy feeds are normally made to leave a safe amount of metal—customarily not less than 0.030 in. thick—as stock on the pass.

If the roll is then immediately finished in the contour lathe, the finishing operation requires removal only of the remaining 0.030-in. thick metal in a light cut which produces no appreciable sidewise deflection of the tool post. Any slight grooving which might occur, if feed is stopped during such a light finishing cut, can additionally be guarded against by coincident operator-stopping of the lathe. Where the contour-roughed roll is on the other hand scheduled for finishing in a block lathe, a heavier amount of stock of about 0.050 to 0.060 in. is normally left on the pass. The additional stock provides for greater safety against undercutting when rough contouring and will, therefore, permit heavier cuts and feeds with less operator attention. In a finishing block lathe, the difference between removal of 0.050- to 0.060-in. stock as against 0.030-in. stock does not noticeably affect finishing time.

To minimize sidewise tool deflection, a recently-built 60-in. lathe and others now being manufactured have tool posts approximately 3¼ in. wide rather than the earlier 2¼ in. width. The newer contouring lathes will also have, in addition to a center tool holder mainly for finishing work, shorter tool holders with minimum sidewise deflection, rigidly mounted on the side of the cross slide. These will be used for heavy roughing or straight turning where a large amount of metal must be removed.

DUPLICATING EQUIPMENT

Because on these large lathes the mechanics of the contouring operation is of interest, a brief description of the electronic dual-motion duplicating system most often supplied follows: The duplicator equipment includes a tracer head, or follower (with stylus), an operator's control box, an electronic control unit with two power supply sections, one cross-feed motor and one long-feed motor. The tracer head is mounted at the operator's end of the carriage cross slide: the cutting tool is mounted on the other end of the carriage cross slide. Any movement of the tracer head, brought about by operation of the feed motors, results in an identical movement of the cutting tool. Figure 12 shows cross slide, tool and stylus.

The follower takes information from the template in the form of stylus point displacement, and transforms this information into an electrical signal which passes through the control unit and through the cross- and long-feed power sections to control the velocities of the two feed motors.

When the follower is away from the template, the stylus is in a perpendicular position; the duplicating equipment is then inactive, and remains inactive until the stylus is brought into contact with the template by manually-controlled operation. Following contact, as template pressure is applied to the stylus point, stylus deflection from the perpendicular occurs until at about 0.005 in., deflection zero signal output from the stylus is reached. Under this condition of deflection—producing zero stylus signal—the duplicator is in operating condition. Assuming that the duplicating switch is thrown, defining direction of tool travel either toward or away from the headstock, the tracer head will move along the template with constant deflection.

Operating characteristics of the follower are such that deflection amounts less than the normal zero-signal deflection transmit a signal phased to produce cross-feed motor rotation for forward motion of the cutting tool. Deflections greater in amount than the zero-signal deflection will produce a signal increasing in magnitude as deflection increases, but 180 degrees out of phase with the original voltage, so that cross-feed direction is reversed. For the purpose of controlling the speeds of the feed motors, a stylus signal varying in magnitude from 0 to 1.5 volts either side of zero is used; voltages greater than the maximum are used for relay control. With maximum sensitivity, this working range of 1.5 volts either side of zero-signal corresponds to a stylus point deflection of approximately 0.002 in. either side of the zero-signal position.

As apart from the operation of the lathe under automatic duplicating conditions, separate manual tool motion control is provided for positioning of the tool prior to duplicator take-over, and for straight rough turning of collars, facing and roughing out passes.

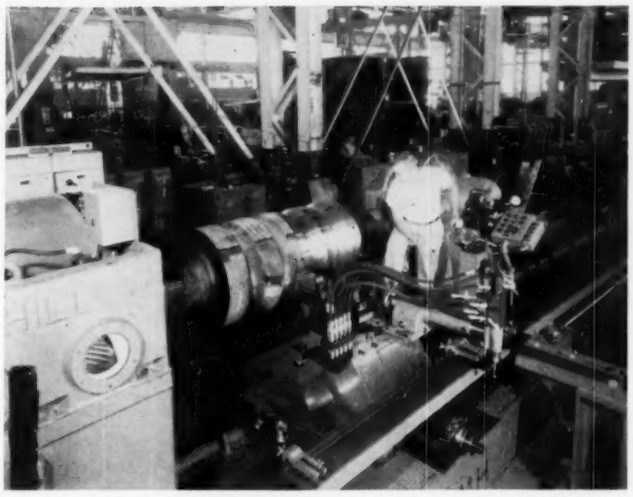


Figure 13—This 60-in. hydraulic contouring roll lathe shows view of tool carriage.

In addition to the contouring lathes, we have built with electronic dual-motion duplicator as just described, two of our 60-in. machines have other types of duplicating equipment. One uses an electronic two-motion duplicator; the other uses a hydraulic duplicator including hydraulic motors for the long- and cross-feed tool motions. See Figure 13, a 60-in. hydraulic contouring lathe.

The latter machine is of more than ordinary interest because it employs unusual means to eliminate or minimize as much as possible the duplicator inaccuracies resulting from lost motion or backlash in the tool feed system. In the hydraulic duplicator lathe, the long- and cross-feed systems use recirculating ball-race nuts on feed screws having suitably ground threads. Each nut is made in two sections so that the nut assembly can be preloaded for backlash elimination. An added gain here is the high efficiency feed power transmission achieved by the antifriction ball-nut and screw.

CONSIDERATIONS IN THE APPLICATION AND USE OF CONTOURING ROLL LATHES

1. *Crane service*—Should be adequate for roll handling. Good crane service is necessary to reduce idle machine time.

2. *Tool coolant*—Although coolant system has been supplied on most of these large contouring lathes, coolant application to the tool has generally not been used for reasons of cleanliness, possible worker allergy, danger from slippery way surfaces, etc. Where used, no appreciable gain in tool life observed. Consensus is that coolant, if not properly applied, will shorten tool life through thermal shock rather than increase it.

3. *Turning on roll housings versus turning on centers*—Use of roll housings increases accuracy of contouring and permits "loose" driving connection between face plate and roll wabbler. Roll housings, however, increase setup time so that the trend is definitely toward turning on centers where possible. In one roll shop, an experimental centering device of considerable promise has been used to support the universal coupling end of a large blooming mill roll turned on centers. When wabbler-end rolls are turned on centers, a "tight" driving connection to faceplate is desirable.

4. Control of carbide tools and tool shanks—Good housekeeping in issuance of button tools, other carbide inserts and tool shanks is desirable for proper control of tool life and tool costs.

5. Preventive maintenance—Periodic inspection of mechanical parts of the lathe together with a careful periodic check of the duplicating equipment is recommended. Where electronic, duplicator check should include testing and consideration should be given to possible replacement on a minimum-life-basis of some components.

6. Future trends—From our experience in observing these large automatic contouring roll lathes in operation, we have concluded that these equipments have filled an existing and important need. Comparatively they are still new in the roll shop picture and a great deal remains to be learned about their best and most profitable application and operation.

That they have been well accepted by industry has been demonstrated by the number of our machines built, on order, and under consideration. Three are in use, one has just been delivered, four are in manufacturing process and several others are being negotiated.

For the future, these large contouring roll lathes give promise of eventually assuming practically all of the great bulk of roll roughing work and most of the primary mill roll finishing work presently handled at high cost in block lathes. In taking over these heavy work areas where highly-skilled labor is least needed, these automatic duplicating lathes will direct roll turners toward more precise and critical roll-servicing operations where their many years of experience can be used to better advantage.

Discussion

PRESENTED BY

JOHN C. REYNOLDS, Roll Turning Dept., Pittsburgh Works Div., Jones & Laughlin Steel Corp., Pittsburgh, Pa.

GEORGE BREZA, Chief Engineer, Mackintosh-Hemphill Div., E. W. Bliss Co., Pittsburgh, Pa.

NICHOLAS POWELL, Assistant Superintendent Roll Dept., Inland Steel Co., Indiana Harbor Works, East Chicago, Ind.

M. L. WEIKERT, Superintendent Roll Shops, Bethlehem Steel Co., Sparrows Point, Md.

J. RALPH PATTERSON, Vice President, Mackintosh-Hemphill Div., E. W. Bliss Co., Pittsburgh, Pa.

EARL M. BENEDICT, Superintendent Roll Shop, South Works, Jones & Laughlin Steel Corp., Chicago, Ill.

W. J. WARTINBEE, Application Engineer, General Electric Co., Pittsburgh, Pa.

John C. Reynolds: The complimentary reference to skilled roll turners is a very nice recognition of a profession which is practically unknown except to rolling mills and roll foundries. It is only too true that we are losing our best men through retirement, and replacements have not been keeping pace.

Our concern at Jones & Laughlin, with the 60-in. contour lathe at the outset, was lack of operator experience. Our operators were only familiar with block lathes and considerable training time was consumed to acquaint them with this new contour lathe.

Our men also had to familiarize themselves with grinding the tungsten-carbide cutting tools which are so necessary for best results. A coolant system was abandoned due to tool breakage.

The insert neck bearing segments had to be changed for each size roll neck and considerable time was lost in this operation due to the difficulty in adjusting for the proper alignment. For this reason we are using the live centers for most of the work.

We have been using the live centers for turning all new blooming mill rolls where the necking center strap is still in place over the driving end. By use of the carbide cutting tools on our new contour 60-in. roll turning lathe, we have obtained a versatility of work which would not otherwise be possible. In our Pittsburgh Works Div., the servicing of 28-in. billet mill rolls, the 22-in. roughing rolls for the 14-in. bar mill, special cutting on the strip mill work rolls, welded coiler cones and finishing rolls for the cold finishing dept.—all of these services indicate the results we are getting from this lathe.

For dressing the blooming mill rolls on centers, we have devised a centered insert for the driving end. We lose considerable time in adjusting this device and hope to improve its design in the near future.

After installation of this lathe, in order to prepare rolls for the mill without changing to another machine, we requested the manufacturer to design and furnish a ragging or fluting device. We have tried this device several times. With a few minor changes, probably on the cam, we feel reasonably sure this equipment will perform satisfactorily. Perhaps the author would offer us any ideas he may have on progress being made for refinements to the device to obtain ragging or fluting that will meet requirements.

There is no question that contour lathes have a very worthwhile value in a steel plant roll service dept. and that their value will increase, particularly with the continual improvements being made in their design. I would like to know if, in any improvements contemplated, consideration is given to application of such improvements to existing contour lathes.

George Breza: Regarding your ragging equipment; this was our first attempt at ragging, and was somewhat experimental. We do feel that we have a solution for you and will discuss it with you very soon.

Regarding the second question of applying new improvements to old lathes: we have been in the lathe-building business a good many years and we realize that times change and that the earlier lathes should have the new features added to them. For that reason, and wherever possible, improvements are designed so that they can be applied to existing lathes.

Rapid traverse on the tailstock and the housings are typical improvements. We feel that these units can be attached to existing lathes.

Another thing that we are doing right now is converting the headstock on an existing lathe from straight gearing to herringbone type gearing.

Nicholas Powell: In the two years that the 48-in. electronically controlled contouring lathe has been in operation at Inland Steel Co.'s roll shop, it is my opinion that we have only scratched the surface of the

lathe's potentialities. We still have some setup and tooling problems which will be overcome by operator education, tool design and experience. The lathe is definitely a time saver on all heavy cutting and roughing operations over standard lathes. We can finish primary mill rolls and roughing rolls ready for mill use. The contour lathe has been a great help in maintaining a heavy roll turning schedule. An advantage is gained in being able to cycle rolls more rapidly.

There seem to be more than a few compelling reasons for adopting contour lathes in the modern roll shops. Mr. Hyams has mentioned most of these. Not the least is the advantage of being able to rush turning jobs to completion against deadlines such as replacing broken rolls in emergency breakdowns and preparing rolls for new sections. In some instances, speed of roll preparation makes the difference between satisfying the trade and booking orders.

M. L. Weikert: Single point tool turning at higher speeds, made possible by the use of cemented carbide tools, has made great advancement in recent years.

A few years ago, with the scrapping of a mill, four block lathes of the 1890 vintage were scrapped. If a new block lathe were purchased today it would have a better head stock, but the tool manipulation would be the same. This method of manipulation must be around one hundred years old.

The use of shaped cemented carbide tools in these lathes is neither practicable nor economical.

When Mr. Hyams mentioned lathes for turning small and medium sized rolls he was speaking principally of engine lathes turning rolls on centers. Turning the small rolls on necks is preferred where accuracy is more important and where the job can be done with fewer cuts and longer tool life.

Little attention is being paid to the smaller lathes turning rolls on necks. Recently one steel plant purchased a lathe from England with the contouring equipment to be attached in this country. This would lead us to believe that some engineering thought should be given to the automatic contour turning of small mill rolls.

There is probably a need for 18- and 26-in. contour turning roll lathes capable of turning rolls on necks in the steel industry with the source of supply very limited.

Our newly formed company is interested in the subject of contour turning all sized rolls.

George Breza: Our company has specialized in larger lathes. The smallest lathes to date have been the 48-in. swing machine. We are thinking strongly of going into the smaller contour lathe field and at present are designing a 36-in. lathe. Later we may develop 26- and 18-in. contour lathes.

J. Ralph Patterson: I would like to ask Mr. Breza, in comparing turning times, how does the contour lathe compare with the old-fashioned block tool, three to one, four to one, two to one or what?

George Breza: Depending on class of work, it can vary from three to one to about eight to one.

Earl M. Benedict: Tomorrow morning we start up the hydraulic lathe that was shown on the screen—the 60-in. hydraulic tracer. You may be interested in knowing why we wanted hydraulic lathes instead of electronic.

We are starting a new structural mill next year, and we have 373 sets of rolls to prepare for the mill. We are purchasing the rolls in the rough. The smallest rolls are 30-in. pitch.

We do not have the time that it seems is required to work the troubles out of an electronic systems. Not only are we short of roll turners, but we are also short of the skilled people required to maintain electronic equipment. So hydraulic lathes were purchased with the idea that the additional start-up and maintenance may be simpler than in the electronic lathe.

W. J. Wartinbee: Mr. Hyams' paper points out the factors which an expanded production capacity have imposed on roll shops and the need for new turning techniques to compensate for machine limitations and a dwindling supply of skilled roll turners. We have made over 500 installations in varied industries so you can see that the need for experimentation has past and job-proven systems are now available. Until recently, the steel industry has used little, or no, contouring equipment, but judging from the number of roll lathe inquiries involving it, there is no question that interest is growing and more roll shop operators are investigating its potential for roll cost reduction.

There are a wide variety of basically different types of tracer controls, as well as, many different manufacturers. It is most important that the proper type tracer be applied to meet the user's requirement. For instance a single dimension hydraulic tracer cannot be used for facing both sides of the groove in a roll unless the roll is unchucked and rechucked end for end. Yet many of the tracer controls applied to lathes are of the single dimension type.

Two-dimension control has been used on most of the author's roll lathes and we feel it lends itself well to this application. Through the "steering" action of the stylus, both feed motors are controlled simultaneously and the tool travels along the template at the same speed regardless of direction. An additional feature, constant chip thickness, can be added, if desired, by the addition of a tachometer generator and control to modify the contouring speed in proportion to the spindle speed.

Wide speed range, adjustable voltage, spindle drives have been used to give more versatility to the lathe. You will note that both of the lathes given in the comparison by Mr. Hyams had speed ranges of 24 to 1 and with only one gear change, a spindle speed range of approximately 100 to 1 was obtained. The availability of packaged type d-c drives makes this system especially attractive. By "packaged type" drives I mean those in which the motor-generator set, the a-c and d-c control, plus the auxiliary motor control are all factory assembled in one sheet metal enclosure. Being compact, the equipment can be mounted near the lathe; being self-contained, only one power source (the a-c supply) need be brought to it; and being factory wired, the amount of interconnecting wiring is reduced.

Constant surface cutting speed operation is often added to take advantage of the speed flexibility inherent in the adjustable voltage system. This is particularly valuable for deep grooves where long facing cuts and various work diameters are encountered. To obtain it, a multi-turn potentiometer is driven from the cross-feed, and the speed of the spindle is increased as the tool advances toward the center of the work. ▲

Trends in Steel Mill Power Plants

. . . . the trend in steel power plants is to higher pressures, higher temperature, larger capacity, and more efficient equipment . . . . it is believed that steam conditions in the order of 1250 psig, 975 F, may become fairly common in the larger steel mills . . . .

by Howard G. Kitt
Senior Power Engineer
and Robert W. Worley,
Chief Power Engineer
United Engineers & Constructors, Inc.,
Philadelphia, Pa.

THE steel mill power plant has been looked upon by many steel management men as a necessary nuisance which must be tolerated and for which a minimum capital investment should always be the foremost goal. This viewpoint often goes a step farther by stating, "we are in the iron and steel business—not the power business." There are occasional instances where these ideas may be justified, but in most cases adequate consideration of the power and steam requirements for a steel mill will indicate the advantages and profit potential of a well designed power plant.

In the past ten years the steel producing companies have installed steam generating capacity totaling some 20,000,000 lb per hr and about 690,000 kw of electrical generating capacity. It is evident that steel producers are of necessity "in the power business."

The iron and steel industry is one of the largest users of electrical power. The production and rolling of an ingot ton of steel requires 150 to 200 kwhr. The kwhr per ton varies above and below this range depending on the product of the mill; this is, however, a fair average for the industry.

The steel output in 1956 was on the order of 115,000,000 tons and represents the consumption of about 20,000,000,000 kwhr. Based on a 65 per cent annual load factor, which is fairly representative, this demand would require an installed capacity of 3,500,000 kw. This is a sizable block of power and is equivalent to about three per cent of the 1956 installed capacity of the nation's utility industry.

In the past the primary reason for the construction of a steel mill power plant has been the availability of by-product fuels. Another very important reason is the demand for medium and low pressure steam in large quantities for operation of blast furnace blowing equipment, mill engines, steam-operated mechanical drives and miscellaneous heating and process uses.

For many years attention has been given to waste and by-product fuels available in steel works, which usually contain potential heat energy to generate all power and steam requirements. These by-products have not generally been utilized in the most efficient manner. This was easily justified on the basis of excess quantities; however, developments over the past few years have provided many profitable uses for such by-products as coke-oven gas, blast-furnace gas, tar, etc. For many years these were used only as boiler fuel with little or no thought being given to improvement of fuel-burning equipment. Now, the use of coke-oven gas for open hearths and reheating furnaces has become common, blast furnace gas is being used in increased amounts for underfiring coke-oven batteries, and the sale of tar products for highway construction is expanding. Consequently, the availability of these products for generation of steam has been sharply curtailed and it is essential that attention be given to improving the efficiencies of power plants for steel mills.

Of the steam generating capacity installed by steel producing companies in the past ten years, 87 per cent

is in multi-fuel units using purchased oil or coal as one of the fuels. About eight per cent is entirely coal-fired and slightly less than one per cent is fired with oil or natural gas as the only fuel. Thus, 96 per cent of this capacity depends in part or wholly on the use of purchased fuel. An improvement in the efficiency of the power plant, or in the use of the steam or electric power generated, will result in a saving of purchased fuel. Many times in the past, blast furnace gas and other by-product fuels have been wasted rather than make the necessary capital investment for their use because of estimated low returns. The diminishing supply of by-product fuels for steam and power production paralleled by increases in the cost of purchased fuels now makes necessary more careful consideration of the complete and efficient use of all available fuels. Savings in power production are actually savings in the cost of purchased fuels. Capital expenditures for power plant improvements and use of their output can now be justified on the basis of purchased fuel costs.

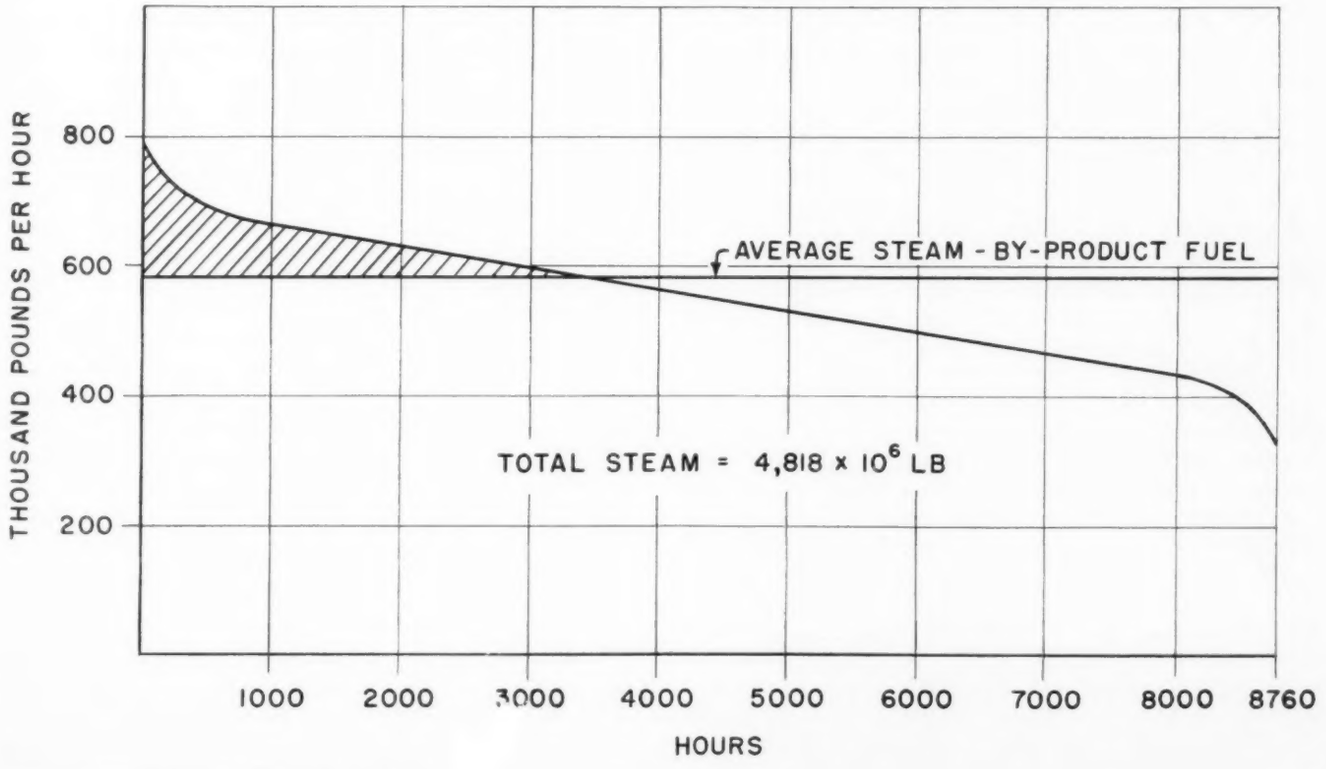
The demand for large quantities of low pressure steam requires the installation of steam generating equipment. With relatively small incremental capital investment, these steam generators can be built to produce steam at high pressure which can be passed through topping or controlled extraction turbogenerators to supply a large portion of the electrical power requirements of the steel mill. It is interesting to note that approximately 45 per cent of the electric generating capacity installed in the past ten years by producing steel mills is of these two types of turbogenerators. Load demands for steam and electric power do not always coincide with the availability of by-product fuels. It is, therefore, sometimes advantageous to combine topping units with full condensing units in the steel mill power plant to obtain full utilization of by-product fuels.

The efficiency level to be adopted for a new or expanded steel mill power plant depends upon the plant steam and power loads, the availability of by-product fuel and the cost of supplementary purchased fuels. There may be times when the available by-product fuel is not sufficient to carry the load while at other times this fuel availability exceeds the load requirements.

A method of analyzing load fuel relations may be of interest. A load duration diagram as shown by Figure 1 is constructed to show the total plant steam requirements for all purposes over a year's period. This chart is developed by plotting hourly steam loads for the entire year from left to right in the order of descending magnitude. The area circumscribed by this line when referred to the proper scale is equivalent to the total steam requirement. In the original of this diagram, the scale is 200,000,000 lb of steam per sq in. of graph and the total steam requirement for the year is 4,818,-000,000 lb. The quantity of steam that can be produced hourly from the average surplus blast furnace gas and other by-product fuels available for use in boilers is plotted as a solid straight line across the diagram. The area below this line will be equivalent to the annual total steam that could be generated with by-product fuel. The shaded area above this line will be equivalent to the quantity of steam that must be generated with purchased fuel. The area above the load curve and below the fuel availability line indicates waste of by-product fuel because steam load for this part of the year is less than the fuel availability.

The preparation of a load duration curve is not as onerous a task as it might appear. If actual loads over the year are tabulated in groups differing by an appropriate increment, and the number of hours determined for each increment, then data for the curve can be prepared in a relatively short time. A smooth

Figure 1 — Curve shows typical method of analyzing steam load duration



curve is plotted with these points as a guide. Load curves drawn for a number of different years will never exactly coincide, but this curve probably presents a fair picture of the conditions that will exist in an extended period, unless some radical change is made in the plant. Our experience in analyzing a great many plants indicates that the duration curve for a particular plant has a characteristic shape that does not vary greatly from year to year, even though there may be considerable fluctuation in the rate of operations. The maximum and minimum loads do not change materially with varying rates of operation—the curve tending only to sag between extreme points when the rate of operation decreases. The duration curve can be used for many other factors in power plant analyses.

Within the last ten to fifteen years the general level of steam pressures and temperatures used for power generating has materially increased. In the utility field, pressures of 1800 to 2300 psig have become almost universal for the larger installations with steam temperatures of 1000 F and higher. The reheat cycle is coming into quite general use. In this cycle, the steam is passed part way through the turbine and then returned to the steam generator where it is reheated to, or near to, the original throttle temperature. The principal advantage of this cycle is that it permits a greater amount of heat per pound of steam to be converted into power. While the reheat systems can handle varying loads, they are best suited to relatively steady load operation.

Within the past year, one utility power plant which uses steam in the super-critical range at 4500 psig and with two stages of reheat has been put into service. Several other such plants are under construction. These higher pressures and the reheat cycle are suitable for large installations with generating units in the capacity range of 75,000 kw and larger. This size unit is considerably larger than those usually found economical in the steel plant. Reliability and simplicity are of primary importance in the steel plant, and the use of very high pressures and the complications of reheating usually cannot be justified.

Industrial power plants in general have followed the trend of the utilities to higher pressure and temperatures. The steel industry is no exception. Approximately 25 to 30 per cent of the steam generating units installed by steel mills in the past ten years have been for pressures over 500 psig and temperatures above 750 F. Single unit capacities have been as large as 600,000 lb per hr. Operating conditions of 900 psig, 900 F have become common practice. Since units of this pressure have proved reliable, plant expansion at 1250 psig, 975 F is now being considered, because the returns on the incremental capital investment appear attractive. The pressure and temperature statements made above apply to plants burning the by-product fuels. Plants for producing power for the processing of low grade ore are being built or projected at 1400 and 1800 psig with reheat cycle using steam at 1000/1000 F. Another natural development has been the increase in size of the steam generating equipment installed. In the past ten years, the number of units having capacities of 300,000 lb per hr and over is only about 12½ per cent, however these units represent about 30½ per cent of the total steam generating capacity. While the units having capacities below 100,000 lb of steam per hr account for 48 per cent of the total number, they represent only 15 per cent of the total capacity.

Electrical equipment is much the same in steel mill power plants as it is in other plants. The design of steam generating equipment has been improving in efficiency. Superheat control for the higher temperature units has become common. Improved over-all efficiency and reliability resulting from use of combustion control equipment has also made the use of this aid to the operators almost universal. Many mills now find it desirable to install dust collecting equipment to reduce air pollution. The necessity for electrostatic precipitators to clean blast furnace gas for stoves, soaking pits and underfiring coke ovens has benefited the power plant. Cleaning gas burners is not quite as much of a chore as it has been in the past.

Improvements in the use of steam and power generated by the steel mill plant are a fruitful source of lower costs. During World War II the demand for iron and steel made it essential to modernize blowing equipment for blast furnaces in order to increase production as much as possible for existing installations. Also, many new blast furnaces were installed which required new blowing equipment. In most instances, existing reciprocating engines, neither gas or steam driven, were replaced by turboblowers. The early applications included units having a capacity of 90,000 cfm at 20 psig and these units were usually allocated to supply blast air on a unit basis, that is, one turboblower for each blast furnace. As the size of the blast furnaces increased and the air requirements grew, it was necessary to install larger units and in many cases the blowing pressure was higher. Capacities of 100,000 cfm at 30 psig became very common, and in a few cases 125,000 cfm, 40 psig units were installed.

The development of larger size blowers indicated a trend which offered the opportunity of installing single units of larger size to blow several furnaces at the same time. The development of successful splitwind blowing control has led to the installation of fewer blowers, and a greater flexibility is possible through the interchange of blowing loads.

In a few cases turboblowers have been installed for operation from high pressure steam, and some instances include back-pressure exhaust at 150 to 250 psig. An analysis of most of the heat cycles for steel mill power plants indicates that the nature of the blowing load for an individual blast furnace does not make a topping unit particularly suitable for this service; however, the advent of split wind installations does permit base loading of turboblowers which may make the operation of the topping unit more advantageous.

Within the past ten years considerable progress has been made in the development of gas turbines as prime movers for electric generation. To date, the largest unit built of which the authors are aware, has a capacity of 27,000 kw. No doubt this will be exceeded, but there is a limit to the size of these gas turbines because a large part of the power developed in the turbine has to be used for combustion air. The fact that most steel plants have a considerable amount of

blast furnace gas available provides a new incentive for consideration of this equipment. At present one steel company is working with a manufacturer in the development of a turboblower which will be gas turbine powered. In this case, the compressor required to provide combustion air has been enlarged so that it can supply blast air for the furnaces as well as the air required for the gas turbine. Several papers have been presented to the AISE on this subject. No doubt, the future holds possibilities for this equipment, but there is still considerable development work to be done before this will be entirely practical.

Every steel mill requires large quantities of cooling water and a considerable amount of power, both steam and electrical, is used in pumping this water throughout the mill. In most mills very little attention is paid to conservation of this water. Frequently, almost the same amount of cold water is pumped in the winter time as is used in the summer when the water temperatures are high. It has long been a common practice in the utility industry to save auxiliary power costs by shutting down pumps in the winter when a smaller quantity of cold water will adequately meet the plant cooling water requirements. We believe a similar procedure may be followed, to their advantage, by steel mills. The return on necessary control equipment for saving condenser circulating water is extremely high.

With the trend to higher steam pressures, the problem of obtaining adequate supplies of water for boiler feed becomes more acute. Most steel plants in this country have been located near navigable waters, but this does not assure an adequate supply of water which can easily be prepared for high pressure boiler use. In most steel plants the demand for steam for process uses eliminates the posibility of return condensate in quantities similar to those found in the public utility power generating station. As a result, it is necessary that very carefully designed and rather costly water preparation plants be installed to provide up to 100 per cent make-up water for the boilers. The chemical content of water supply varies greatly between locations and, as a consequence, no single scheme of water treatment has yet been developed which can be used for all sites. Proper treatment of water for high pressure boiler is a specialty requiring the service of a trained water chemist of broad experience, in the development of the proper design for a water treating plant. Great strides have been made in hot lime-soda, hot zeolite water treating and in demineralizing processes which have made it possible to use river waters successfully for high pressure boilers with a high percentage of makeup.

Due to the fact that many of the large steel works in the United States were started early in the century, 25-cycle energy was the most satisfactory for large rolling mill drives where low speed, direct-connected equipment was required; as a consequence, many of the companies have large 25-cycle systems still in existence. At that early date, the utility companies had not yet standardized on any particular frequency and 25, 40 and 60 cycles per sec appeared quite common. Today, 60 cycles per sec has been universally accepted as the standard frequency for public utilities in this country; consequently, procurement of new 25-cycle equipment for the steel mill involves some additional cost and delays in delivery. Steel plants are now faced with the necessity of making a decision whether to continue to extend their 25-cycle equipment or to set up a definite program of conversion to 60-cycle power. If the latter is done, all of the existing mill equipment can be converted as it becomes obsolete and needs to be replaced. Any conversion to a different frequency power system probably will involve extensive transmission facility duplication which may be hard to justify under present economic conditions. The trend to installation of 60-cycle equipment by steel mills is evidenced by the fact that about 80 per cent of the new generating capacity installed since the War has been 60 cycle. This trend has been accelerated by ease of interconnection with local utility companies for electric power requirements in excess of those which could be generated from by-product fuels.

As previously mentioned, the trend in steel mill power plants is to higher pressures, temperatures, larger capacity and more efficient equipment. We would expect steam conditions in the order of 1250 psig, 975 F to become fairly common in the larger steel mills. Except for the characteristics required for burning blast furnace gas, we would not expect steam generating equipment for steel mill plants to be radically different from other industrial or utility units of comparable size. Due to the decreased availability of by-product fuels and the increased cost of purchased fuels, we anticipate that the fuel and operating departments will pay much closer attention to improving the station heat rates and to more efficient use of the steam and electric power produced by the steel mill plant.

Discussion

PRESENTED BY

J. P. KATZENMEYER, Maintenance and Utilities Div., McDonald Mills, United States Steel Corp., Youngstown, Ohio

W. B. WILSON and **I. H. LANDES**, Power Generation Engineering, General Electric Co., Schenectady, N. Y.

H. L. HALSTEAD, Assistant Fuel Engineer, Bethlehem Steel Co., Sparrows Point, Md.

WALTER FLANAGAN, Project Development Engineer, United States Steel Corp., Pittsburgh, Pa.

JOHN J. ALEXANDER, Superintendent of Power, Republic Steel Corp., Cleveland, Ohio

HOWARD G. KITT, Senior Power Engineer, United Engineers & Constructors, Inc., Philadelphia, Pa.

J. P. Katzenmeyer: This informative paper presents many basic considerations in power plant design that should be helpful to engineers and operators interested in replacing old facilities or expanding existing facilities.

Engineers may be interested in how Ohio Works was able to realize the economies made possible by a topping turbine when its inadequate power and steam facilities were replaced in 1953. Two new identical 950-psi, 900 F blast furnace gas-fired boilers, with a rated capacity of 250,000 lb per hr each, were installed to supply steam to a new 15,000-kw, (3-phase, 25-

cycle, 6600-volt) topping turbogenerator. The generator replaced seven twin-tandem gas engine driven 25-cycle generators, but the new high pressure boilers, in combination with the topping turbine, permitted the abandonment of a boiler house; consisting of six underfeed stoker fired boilers, having a total capacity of approximately 400,000 lb per hr and operated at 150 psi and 400 F. Pressure reducing stations were installed to supplement the needs of the plant 150-psi system, as the new generator exhausts into the plant 280-psi, 600 F system, due to the expected future transfer of facilities, as they are replaced, from the 150-psi system to the 280-psi system.

Availability of waste fuel, discussed by the authors, did not present a problem at Ohio Works, as sufficient blast furnace gas is available for 100 per cent firing of the new boilers. However, at times of reduced blast furnace operation, it was found that an auxiliary fuel was necessary for capacity operation of the boilers. Therefore, fuel oil facilities were installed so the economies of the topping turbine could be realized, as the other power facilities consist of combination coal and blast furnace gas-fired boilers, 280-psi, 600 F, supplying steam to condensing turbogenerators.

W. B. Wilson and I. H. Landes: The authors have chosen a subject of great importance to the steel industry. Many of the low-pressure boilers in steel mills today are very inefficient, or have extremely high maintenance, and many agree that they have outlived their useful life. When this obsolete equipment must be replaced, management has an excellent opportunity to install modern, high-pressure boiler plant equipment to reduce mill operating costs.

Turbines can satisfactorily utilize higher initial pressures and temperatures, to greatly increase the by-product kilowatts generated for each pound of low-pressure steam required in the mill. This by-product power can be generated for around 4600 Btu per kwhr, which is perhaps ⅓ to ⅕ the normal fuel chargeable to power in many old generating units in the steel industry. With noncondensing by-product power generation, there is no loss of heat to the condenser and the only items of fuel chargeable to power are the boiler losses, the incremental auxiliary power loss and the mechanical and electrical losses in the turbine-generator units. Figure 2 shows the approximate by-product power that can be generated when 100,000 lb per hr of steam is expanded from various initial steam conditions down to the lower pressures required for process use.

For example, if we use the average steam load of 550,000 lb per hr as shown in Figure 1 of the authors' paper, over 25,000 kw of by-product power can be generated in noncondensing turbine-generators with inlet steam conditions of 1250 psig, 900 F when exhausting at 200 psig. If fuel is valued at 25¢ per million Btu and electric power at 6 mills per kwhr, fuel cost for this 25,000-kw generation would amount to $245,000 per year compared to $1,275,000 total value of the power. This difference of over $1,000,000 is a sizable annual saving that could be applied to labor, maintenance and return on incremental investment required for the installation of these generating facilities.

To give added operating flexibility and to permit full utilization of the by-product fuel, the use of an automatic-extraction condensing turbine instead of a straight noncondensing turbine might be considered.

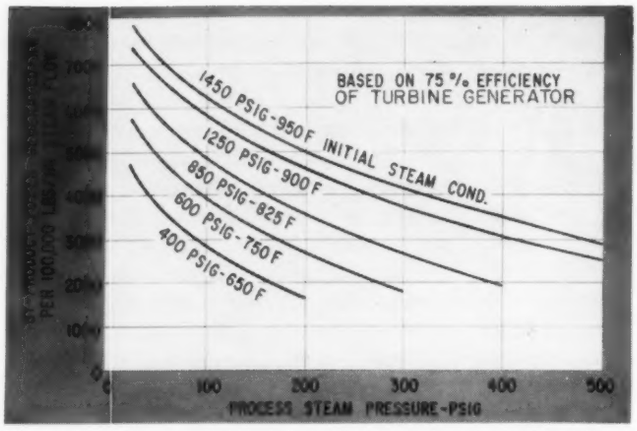


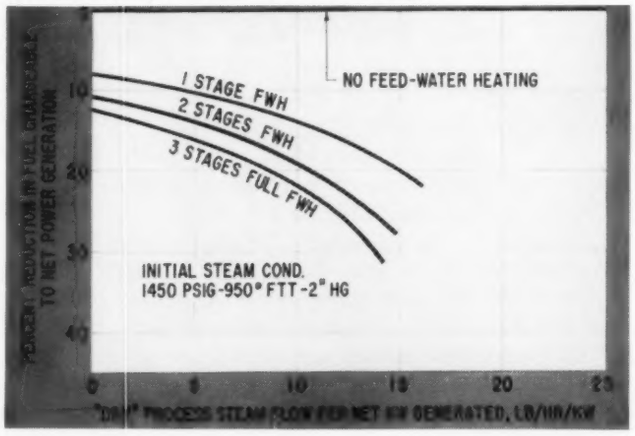
Figure 2 — By-product power that can be generated when steam is expanded from various initial steam conditions to the lower pressures required for process.

FEEDWATER HEATING

In addition to higher initial steam conditions, feedwater heating can increase the by-product kw that can be generated. If the mill is generating any condensing power, the reduction in fuel chargeable to net power generation is illustrated in Figure 3. This curve happens to be based on a 1450 psig, 950 F double extraction turbine with one half extraction flow at 150 psig and one half at 50 psig, but the same general benefits are derived regardless of extraction pressure. Note that this curve shows an increased efficiency of approximately 10 per cent in mills requiring little or no process steam up to approximately 30 per cent when process steam requirements are as high as 15 lb per kwhr generated. With greater quantities of feedwater to be heated, it becomes obvious that the use of feedwater heating will result in a correspondingly greater decrease in fuel chargeable to power than in a plant of equal rating installed for power generation only.

The increased cost of fuel and power referred to by the authors makes it economic to install more feedwater heating in steel mill power plants than might

Figure 3 — Per cent reduction in fuel chargeable to power when steam is extracted for feedwater heating (one half flow at 50 psig and one half at 150 psig).



have been considered only a few years ago.

This discussion has dealt mainly with turbine-generators to illustrate some of the advantages of higher pressures and temperatures and more stages of feedwater heating. The discussion is equally applicable to large blast furnace blower drive turbines which are suitable for blowing a single blast furnace or used in a split wind blowing arrangement. When blowing a single furnace with a noncondensing turbine, adequate provision must, of course, be made to provide the process steam required when load on the blower is down. This flexibility can be provided by an automatic-extraction or extraction-admission condensing turbine-generator in the system or even an automatic-extraction turbine on some other blower drive.

Many steel mills are already realizing the benefits of higher pressures and temperatures; let us be sure that none of us misses an opportunity to reduce overall mill operating costs.

H. L. Halstead: At Sparrows Point we have three and are presently installing a fourth boiler operating at nominal header conditions of 850 psig and 900 F total steam temperature. The first two of these boilers have been operating approximately seven years. The four boilers have steaming capacities ranging from 425,000 to 525,000 lb per hr each. These four boilers supply steam to three condensing turbines each producing approximately 38,000 kw of electric power and a noncondensing turbine producing 25,000 kw of power and exhausting into a 275-psi plant steam system. The boilers are fired with a combination of coke breeze and blast furnace gas with fuel oil being used as a make-up fuel.

Since this installation is consistent with the trends noted in the subject paper and since the installation has been a successful one from both the standpoint of reliability of service and economy of operation, a few comments regarding the installation seem to be in order.

1. Conditions at our plant have been particularly favorable toward installing larger size units. We do not believe units of similar size could be similarly justified in most steel plants.

2. Our condition of pressure and temperature are eminently satisfactory. However for a topping or noncondensing installation supplying process or plant steam, the attractive return on the additional investment required would, today, most probably result in going to higher steam conditions.

3. Although our installation operates essentially as a base load station insofar as output is consumed, the extreme variations in blast furnace gas input produce firing and steam temperature control problems just as rugged as an extremely variable load. Since the heart of the economic justification for installing power producing facilities in a steel plant is most certainly the availability of by-product fuel, blast furnace gas must be used productively and used at the instant it becomes available. The problems associated with such use of blast furnace gas are probably unique to the steel plants; they cannot be overemphasized, and they should be considered and reconsidered when designing and selecting control and steam generating equipment for typical steel plant service.

I believe the paper just presented is a good one—the trends indicated are certainly not extreme, and the authors should be congratulated on a paper containing a minimum amount of technical detail but which has covered the subject extremely well.

Walter Flanagan: Power plants and certain facilities for the utilization of fuels and heat developed in the production of coke, iron and ingots, generally return a higher yield on the investment than most of the manufacturing facilities.

This is due to the fact that the installed cost of power plants, for example, has not increased in the same proportion as other steel works investments.

The power plant has to compete, however, with equipment which affects quantity and quality of production.

Integrated steel works power plants have for the last few decades varied from public utility plants only in the matter of size of units, fuels and steam conditions.

The basic steel works power plant has blast furnace gas as primary fuel. To meet periods of blast furnace outage a secondary fuel is usually supplied. Coal, due to price and other characteristics is the most desirable secondary fuel. Many deviations from a logical pattern may be found on examination to be due to expedients in trying to burn dirty or partially cleaned gas, misuse of gas pressure available, and illogical application of secondary fuel.

Blast furnace gas at the furnace top is available at 2 psi (54-in. H_2O) or higher. This is ample pressure to deliver the gas through modern fine gas cleaning equipment and over the distances generally found in steel works. In addition, it can still have adequate pressure for pressure furnace operation.

Many cases of compromise with obsolete gas cleaners and too small lines have resulted in dirty gas of low pressure requiring burners of compromise design and abnormally large combustion chambers. Attempts to hold down initial investments have used more expensive and less workable secondary fuels such as fuel oil, coke oven, or natural gas or even coke breeze.

Two lessons have been impressed on the industry:

1. Fine cleaning (under 0.0050 g per cu ft) of blast furnace gas is essential whether used by boilers, stoves, gas engines, metallurgical furnaces or otherwise.

2. Blast furnace gas residual dust tends to sinter and adhere to boiler or superheater tubes. When pulverized coal is the secondary fuel, it maintains by its abrasive action, boiler, superheater and economizer tube cleanliness. Oil and gas merely make the deposit more difficult to remove.

To be considered modern, a station should contain new logical design elements which are based on sound engineering and not on a long list of similar installations.

The modern boiler will be at least 950 psi, 900 F fired with blast furnace gas and pulverized secondary fuel. The only reason for such low steam conditions is that the same steam pressure and temperature can be used readily for both turboblowers and turbo-generators. Boiler furnaces will be pressure fired (no induced draft fans).

Efficiency with blast furnace gas 85+ per cent with coal 93 per cent.

REASONS FOR STEEL WORKS TURBOGENERATOR SIZES

Assuming an annual 2,500,000 ingot ton plant. Its average electric load is:

$$\frac{2{,}500{,}000}{8760 \text{ hr}} \times 200 \text{ kwhr per ton} = 57{,}000 \text{ kwhr}$$

Then, if isolated, the works would require for continuity of service:

Two 30,000-kw turbogenerators.

The foregoing station in also taking care of blast furnace blowing and works water pumping requires about 300,000 lb per hr, and can utilize the output of a third large boiler for these services.

The corresponding public utility installation will consist of 300,000-kw units, high pressure (2500 psi+) with at least two stages of reheat.

The smaller steel works plants will consist of 10,000-kw turbogenerators and a few turboblowers of equivalent size. These units are not a logical size for steam conditions over 500 psi, 750 total temperature.

The demand for low pressure steam in a modern integrated open hearth steelworks is just about met by the output of modern open hearth waste heat boilers. This accomplishment is the result of elimination of the steam engine driven mills and steam blowing engines plus improvement in recovery of open hearth waste heat.

Open hearth waste heat recovery is now entering its third cycle as to type of unit.

The first general installations for recovery of heat in open hearth stack gases consisted of the application of then current models of direct fuel-fired boilers, hampered by leaky brick settings, combustion chamber volume (not required), large drums (for the low steam release encountered in open hearth waste heat operation) and tube configurations designed originally for heat transfer by radiation as well as convection. Facilities for coping with slag were meager, and air infiltration with consequent high auxiliary power requirements was high.

By 1925 the obsolete water tube boilers were being supplanted by specially designed fire tube waste heat units which were better applicable to heat transfer by convection. These boilers were limited to a combination of size and pressure by the thickness of the plates required for high pressure and high capacity.

The modern waste heat boiler consists of panels of specifically designed small water tube forced circulation units so arranged as to avoid plugging by open hearth slag. This design is applicable to power house pressures as well as to low pressure steam generation. The panel tube, forced circulation boiler has an inherently high efficiency as its tubes can be arranged for best convection efficiency with a panel type casing to minimize air infiltration, and graduated gas passages to provide for slag.

GAS TURBINES

The use of this type of prime mover seems always to be indicated in connection with a blast furnace plant. Gas is available (after supplying stove heat) for blowing and power.

The attraction of the gas turbine is the exact balancing of propelling fluid with power requirement, i.e. no excess boiler capacity. This advantage is balanced by the requirement to date of an additional large unit, i.e. the blast furnace gas compessor for each turbine or group of turbines.

For equal investment efficiency, characteristics, reliability and operating cost, a steam unit plant and a gas turbine plant are apparently equal. The gas turbine scores an advantage when minimization of water usage is required.

PRESSURE SETTINGS

Due to the fact that practically any blast furnace plant can operate economically at 2 psi or higher top pressure, there is an incentive to use high pressure boiler burners, and high heat release settings.

The only stumbling block is the resistance to gas flow occasioned by poor gas washers, too small lines, water seals and other old equipment. The elimination of such obsolete equipment permits the use of pressure settings without induced draft fans, with resultant investment and operating savings pertinent to smaller combustion chambers and the elimination of induced draft fans.

John J. Alexander: Mr. Kitt and Mr. Worley have presented a very complete and comprehensive discussion of the trend in steel mill power plant design. As stated in their paper, many of the recent installations are multi-fuel units using purchased oil or coal as one of the fuels. Multi-fuel installations are necessary to provide reliable operation of the power plant and to permit efficient operation of boilers at capacity to utilize as much as 80 per cent of the blast furnace gas produced for steam generation.

The paper mentioned split wind blowing and topping turbo blowers. I believe the greater flexibility provided by split wind installation and lower incremental cost for wind to the blast furnace provided by such installations should have been described in more detail.

Mr. Kitt and Mr. Worley should have mentioned the higher availability of the properly designed installation of steel mill high pressure power plant compared to obsolete steam generating equipment.

I do not agree with the typical steam load duration curve. The steam from by-product fuels will vary with rate of operation, coke practice and boiler efficiency. The steam demand for turbogenerators, turboblowers and general plant system will be greater than the quanity available from by-product fuels at least 90 per cent of the year. The curve indicates a surplus of by-product fuels, based upon the average, for 60 per cent of the year. I question the value of a yearly average by-product fuel figure. Coke oven and blast furnace rate of operation changes with the rate of production for open hearth and steel mills. I suggest that the steam from by-product fuels should be correlated more closely with rate of steam production, and that a yearly average from by-product fuels does not provide a satisfactory analysis for determination of purchased fuel consumption.

Howard G. Kitt: We would like to thank all our discussers for their statements and expanding on phases of steel mill power plants which we felt we did not have time to do.

In almost all cases we agree thoroughly with the things they have said.

Mr. Landes mentioned a purchased fuel cost of 25¢. We think that is going to run nearer 40, which will help out on the substantial savings that he has indicated.

Mr. Flanagan was quite correct in his statement that no two steel mill power plants are alike. However, we feel that the principles that we have tried to indicate in the paper will hold true with differences in magnitude and application in almost any mill.

It is also true that the topping turbine is not the best answer in all steel mills, but we feel that an economical combination of topping and condensing units—or if the mill is not large enough for two, a controlled extraction unit will answer a great many of the problems of equalizing the steam demands and the power generation demands.

With regard to Mr. Alexander's comments on the duration curves, over the years we have found this type of curve a very excellent tool for analyzing all power plant operations as well as steel mill power plants.

We agree with his statement that the straight line average used to represent by-product fuel availability on the duration curve does not exactly represent the conditions. This is especially true in plants where periods of gas shortages occur—as in Mr. Alexander's plant. Few, if any, plants maintain by-product fuel production records which would permit plotting the supply in the same manner as the steam demand. If such data could be obtained, it would be more accurate than the average used. However, where there is adequate by-product fuel for peak loads, the use of an average, as shown by the slide, does not seriously affect the accuracy of annual calculations. ▲

Revised and rearranged collection of articles which appeared in the Iron and Steel Engineer between 1943 and 1950 . . . a book for rolling mill men and for anyone interested in rolling mills and roll design . . . written from a practical viewpoint by one who has had considerable experience in the art of roll design.

ROLL DESIGN and MILL LAYOUT

By **ROSS E. BEYNON**

Cloth bound . . .

128 pages . . .

303 illustrations . . .

Price: To AISE Members . . . $3.00
To Others $5.00

ASSOCIATION OF IRON AND STEEL ENGINEERS

1010 Empire Building **Pittsburgh 22, Pa.**

by W. E. Lewis, Manager—Field Sales, Lectromelt Furnace Div., McGraw Edison Co., Pittsburgh, Pa.

Electric Furnace Steel

. . . . this paper emphasizes electric furnace operation on west coast . . . . many of the comments, however, are equally applicable to other parts of the country . . . .

MORE than seven per cent of the steel poured into ingots and steel castings in this country now is melted and refined in direct arc electric furnaces. Other electric furnaces also are busy turning out gray and malleable irons. Much additional capacity is used in smelting type operations.

During 1956, the electric steel poured into ingots approximated 9,000,000 tons. From this the average rate of production of the various grades of electric ingot steel was on the order of 1000 per hr—every hour. Most interesting, the production of electric steel has increased by ten times in the last twenty years. During the last ten years electric steel production for ingots and castings nearly has quadrupled.

Projection studies relating to increasing steel capacity during the next fifteen years assume approximately 50,000,000 tons of yearly capacity will be added to a present capacity of about 140,000,000 tons. Of the new capacity, various predictions call for from 25 to 50 per cent to be added by means of electric furnace installations.

WEST COAST INGOT PRODUCTION

West Coast electric steel production is of great interest. In getting together data on West Coast Steel production, all steel works and all steel foundries in the three westmost states were contacted and a majority replied. In the case of those who have not furnished their figures, we have substituted estimated productions. These latter estimated outputs have been put together in line with American Iron and Steel Institute annual capacities as of January 1957, and from additional information obtained from the Steel Founders Society.

Now California, Oregon and Washington ingot production for 1956 amounted to close to 3,800,000 tons. This figure is based on the component tonnages being ⅔ reported and ⅓ estimated.

Thirty-four open hearths and seventeen electric furnaces were available for this production.

Of interest, one producer using open hearths will put into operation this year two 20 ft-0 in. inside diameter, 25,000-kva, top-charge electric furnaces having a joint productive capacity of 350,000 tons of plain carbon steel.

During 1956, 22 per cent of the ingot steels produced on the West Coast were tapped from electric furnaces. Just over 7 per cent of all electric ingot steel made in the United States is tapped from electric furnaces, so West Coast output of electric steel ingots are three times those averaged country-wide.

When the two 20 ft-0 in. inside diameter, 25,000-kva furnaces previously mentioned are in production, approximately one third of all ingot steels produced on the West Coast will be produced electrically.

It is of interest to note that in 1947 the total ingot steel capacity of California, Oregon and Washington was 2,285,000 tons of which electric furnace capacity only represented 371,000 tons.

In passing, while American Iron and Steel Institute data gives capacities and outputs in terms of ingots and castings made by steel works, the metal those plants put into castings is relatively small. Consider 1955 for example and we have:

Total steel works capacity in ingots and castings	125,823,310 tons
Total output of these plants as ingots and castings	117,036,085
Total steel products shipped	84,717,444
Ingots and steel castings shipped	678,630
Percentage of total shipments as ingots and castings	0.8

Another relationship on which it may be well to comment concerns the amount of steel castings produced country wide during that same year. These were:

Carbon steel castings	1,088,489 tons
Alloy castings including stainless	442,205
High alloy castings	33,288
	1,563,982 tons

Thus, in a typical year, the tonnage of steel castings shipped did not amount weightwise to as much as 1½ per cent of the total tons of ingots produced. Further, we can conclude that roughly about 3 per cent as much tapped steel was required to pour the castings as went into the ingots stripped.

WEST COAST STEEL CASTINGS PRODUCTION

Thirty-nine West Coast steel foundries were addressed for their operating data, and while the response was good tonnagewise, the majority of shops producing under 2000 tons per yr did not send in their figures. However, nearly 90,000 tons of output was reported for

Manufacturing

1956. From capacity data available for those shops not participating, we can conclude the total production of steel castings in the three westmost states last year approximated 100,000 tons and may have exceeded that figure by as much as 10 per cent.

Taking the country-wide production of steel castings to be 1,500,000 tons, it is evident West Coast tonnages approximates 7 per cent of the whole.

Fifteen shops reported yearly productions of over 2000 tons of castings. The average output of these fifteen shops was 443 tons per month.

All shops reporting use arc furnaces.

In the case of the fifteen larger foundries contributing data the following outputs are shown:

1955—69,281 tons of castings
1956—79,684 tons of castings

Data for 1954 cannot be given as one of the larger producers did not have the data available for that year.

Nothing unusual was reported regarding electrode or power consumption. One small shop showed higher power and electrode consumption than normally would be encountered. One of the larger shops indicated power usage as low as 450 kwhr per ton which presumably results in a fast oxygen lancing process. Comments on oxygen lancing (blowing) will be made later in this paper. Most energy usages reported were of such magnitudes per ton as: 507, 520, 540, 560, 590, 617, 550, etc. Electrode consumption per ton reported had the following values: 8.4, 8.3, 7.2, 10.4, 4.7, 13.5, 9.1, 9.4, etc.

DECREASING COSTS OF MAKING ELECTRIC STEELS IN LARGER SIZE ELECTRIC FURNACES

Most of the new electric furnace capacity for ingot steels has been and is being installed for tapping out plain carbon steel. The same equipment, naturally, serves for making low alloy steels and higher alloy grades. In terms of plain carbon steels and assuming the same load factor operations Table I gives the general over-all relationships of various sizes of furnaces.

In general, one furnace will make steel more cheaply than two or more smaller furnaces. However, often there is much more to the entire picture than just teeming the ingots themselves. The optimum size of ingot

TABLE I

Furnace diameter, ft-in.	10-0	15-0	18-0	20-0	24-0
Ingot tons per month	3500	8000	11,500	16,000	24,000
Kva	5000	12,500	18,750	25,000	37,500
Tons per hour	5	12	17	24	35
"Cost above"	$21.80	$19.50	$16.75	$15.45	$14.65
Decrease in "cost above," per cent	...	10	19	28	33

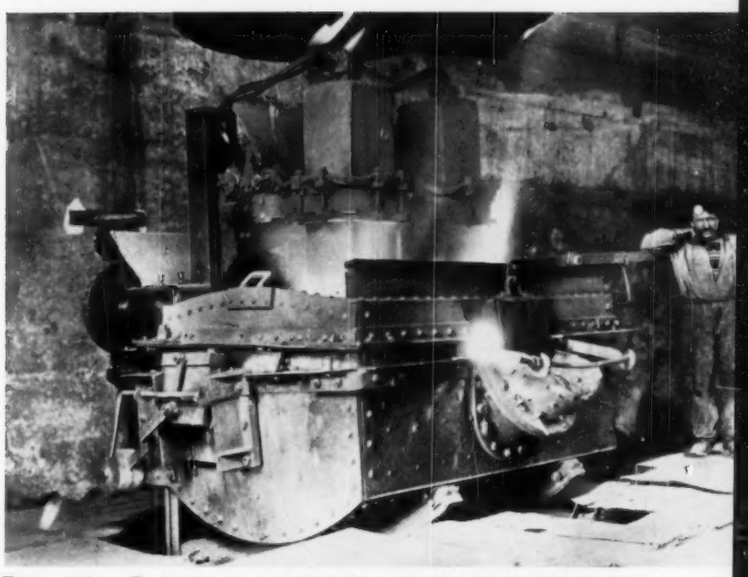


Figure 1 — Early type rectangular single-phase Heroult furnace.

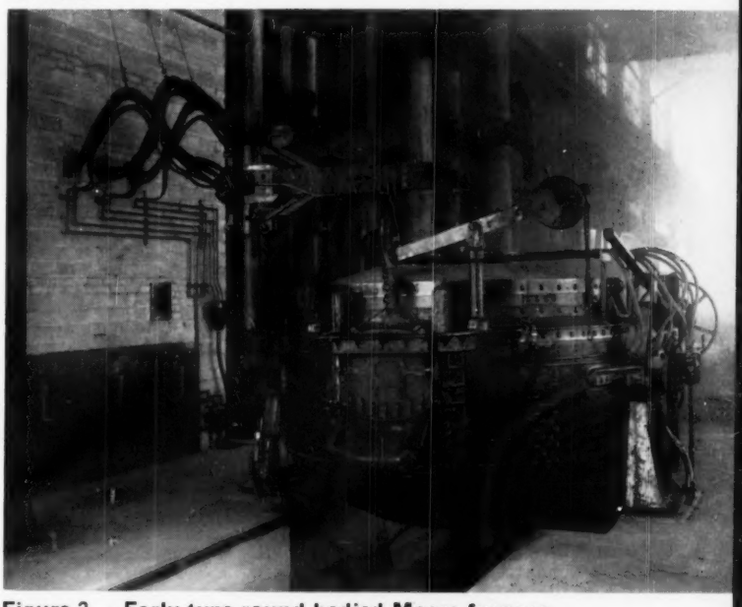
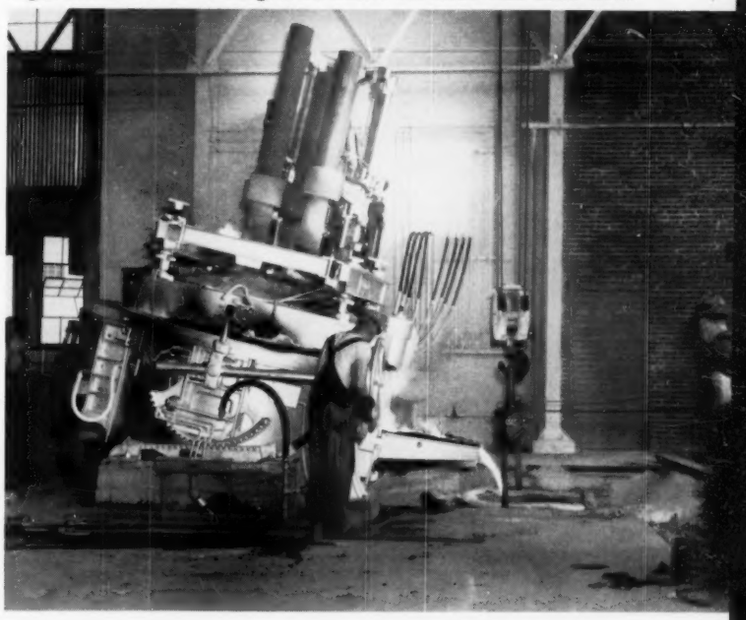


Figure 2 — Early type round bodied Moore furnace.

Figure 3 — This late eight-ft diam furnace has 3500 kva.



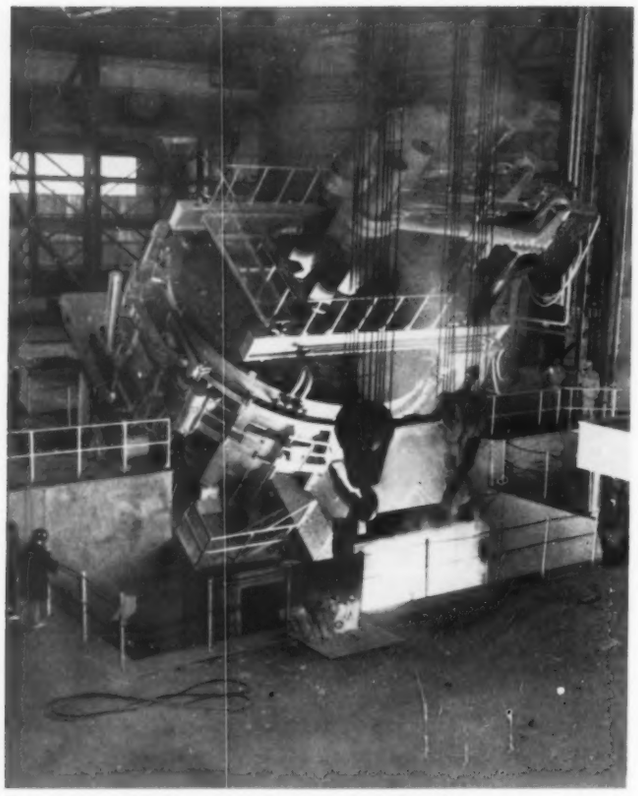


Figure 4 — Cost estimates for this 20-ft diam furnace are discussed in Table II.

for one's rolling mill equipment, diversity in products, plans for future expansion, hours of working, melt shop costs for building and cranes, as well as other considerations enter into the final decision as to furnace size. As well as any trend can be pointed out, there is tendency to advance above the 11-ft diam furnace in the case of the smaller shops and there is some lack of agreement regarding the probable best top size of melting furnace.

Looking at the large size ingot furnaces just installed or under construction, we find five 20-ft diam furnaces, five 22-ft diam furnaces, and five 24-ft diam equipments. Settlement on size, however, in most cases was tied in either with equipment already in use or the building facilities. For example, a shop with a 20-ft diam furnace would favor having the next unit of the same size to facilitate inter-changeability of parts. Then again, the conditions could be such that a larger size would be ruled out through there not being enough available headroom for its installation in an already existent building.

Before passing forward to other aspects of this discussion, it may be well to include typical furnace costs when running at say a 23 to 24 ton per hr rate. Table II accordingly has been prepared. Table III also has been drawn up to further emphasize the decrease in cost with increasing furnace size.

SCRAP SUPPLY

As scrap melting ingot furnace capacity increases, there certainly will be auxiliary installations made to supplement the melting stock with iron reduced from the ore itself. As is well known, sponge iron has been produced successfully in Sweden and elsewhere, although

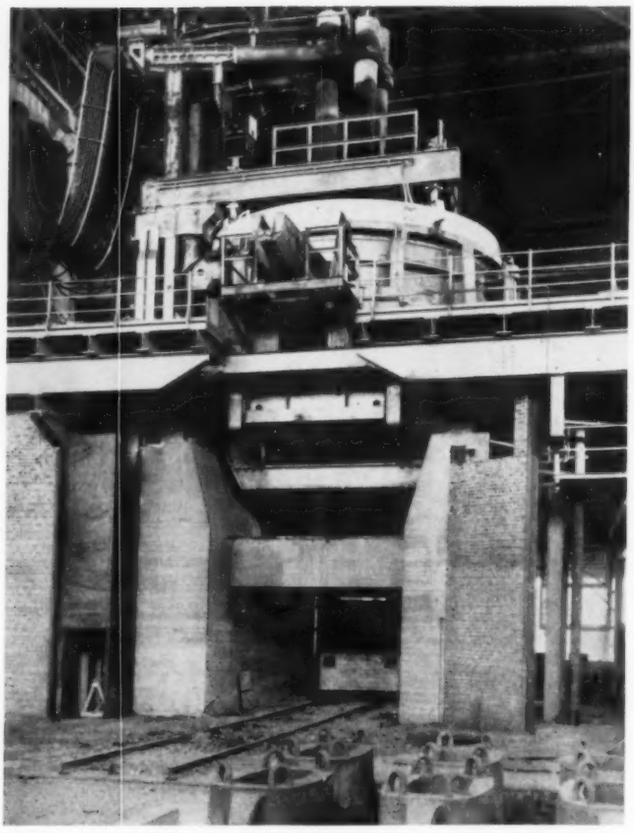
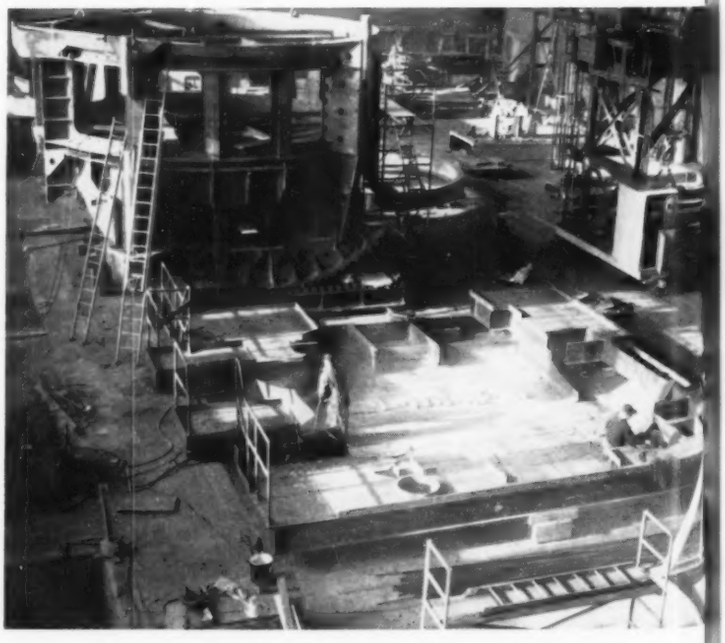


Figure 5 — This 24-ft diam furnace was installed as a platform type.

as yet not in any quantity such as would be needed in a large plant using about half sponge iron in the charges.

The hydrogen reduction of iron ore, another approach to scrap supplementing, has advanced to the pilot plant stage. The product turned out runs 87 to 95 per cent iron. Some sulphur reduction is had. Investigations indicate on the order of $12,000,000 dollars would be required to build a plant having a capacity of 1000 tons per day. At say $10 per ton direct operating cost above the ore cost, a charge material at attractive price should

Figure 6 — Body of 24-ft diam furnace is under construction.



be had. Naturally, the reduced iron would be free of any tramp alloys. The reduced material can be passed through rolls and the resultant sheet about ¼ in. thick is broken into pellets which average about 140 lb to the cu ft.

In another hydrogen reduction operation, the plan is to charge the reduced iron through the roof of a melting furnace.

One Mexican plant is known to be regularly charging hot sponge in its electric furnaces although no details on the savings effected have been made public.

Another approach to scrap supplementation is the production of electric furnace pig iron—this as molten metal, to constitute about half of the furnace charge. Operations with molten blast furnace iron used as about half of the charge have resulted in 10 per cent increase in hourly output.

CONTINUOUS CASTING

Steel now is being cast continuously in an increasing number of plants. Developments in this direction could much encourage the establishment of small independent steel enterprises. The use of this type of casting also could aid plants where melting or finishing capacity exceeds or could be made to exceed existing blooming and/or finishing facilities.

The principal advantages attributed to continuous casting in the case of a merchant mill operation are as follows:

1. This way of working enables billets to be cast directly into small sections suitable for rolling on small bar mills.

2. Higher yield is obtained than when conventional billet size ingots are cast.

3. Continuously cast billets can be removed from the casting machine at approximately 1600 F and charged immediately into a heating furnace.

Plants continuously casting steels are operating in Sweden, Germany, England, Austria and France. One plant operates in Japan. Babcock-Wilcox at Beaver Falls, Pennsylvania is operating a continuous casting machine as is Atlas Steels Ltd. of Welland, Ontario.

TABLE II

Cost Estimate Per Net Ton of Plain Carbon Steel Ingots Using One 25,000-Kva, 13.8-Kv Top-Charge to Produce 16,000 Tons of Ingots Per Month

Assumption: This 20-ft-0 in. inside diameter furnace normally to be in operation twenty 8-hr shifts per week

1.	Charge: 2000-lb light steel scrap at say $55.00 ton (two back charges per heat)	$55.00
2.	Melting and shop loss 8 per cent	4.40
3.	Ferroalloys, iron ore and miscellaneous additions	2.50
4.	Power: 500 kwhr per ton of ingots at say nine mills per kwhr	4.50
5.	Electrodes: 10 lb per ton ingots at $0.23 per lb	2.30
6	Lime and limestone	0.70
7.	Ladle refractory maintenance (including sleeves, nozzles, etc.)	0.25
8.	Molds and stools	1.00
9.	Furnace refractory maintenance (brickwork and labor)	0.75
10.	Magnesite and dolomite	0.70
11.	Ingot shop and scrap yard production labor at $2.75 per man-hour	2.20
12.	Indirect labor including supervision, chemical, metallurgical and clerical	0.40
13.	Oxygen and compressed air; supplies, tools and lubricants; water and utilities, yard switching; slag disposal and general expense	1.75
14.	Employee benefits	0.30
15.	Overheads figured on 15 per cent per yr on a capital investment of approximately $750,000.00 for furnace with its electric substation and control equipment installed and 190 tons of ingots made per yr. This charge to cover interest on investment, maintenance, depreciation, taxes and insurance	0.60
	Per net tons stripped ingots	$77.35
	"Cost above"	$15.45

TABLE III

Decrease in Ingot Costs With Increasing Size of Furnace, Assuming the Same Load Factor and With Scrap Charged to Each Operation at the Same Price

Furnace diameter, ft-in.	Cost of ingots*	Decrease in cost, per cent	Decrease in cost with scrap one dollar less per ton for each increasing size of furnace, per cent
10-0	$83.70		
15-0	81.40	3	4
18-0	79.65	5	7
20-0	77.35	8	11
24-0	76.55	9	13

* Based on $55.00 per net ton scrap, 9 mill power, and ample furnacing costs. Steel as of 2/18/57 shows heavy melting steel and bundles at $52.00 per net ton at Los Angeles.

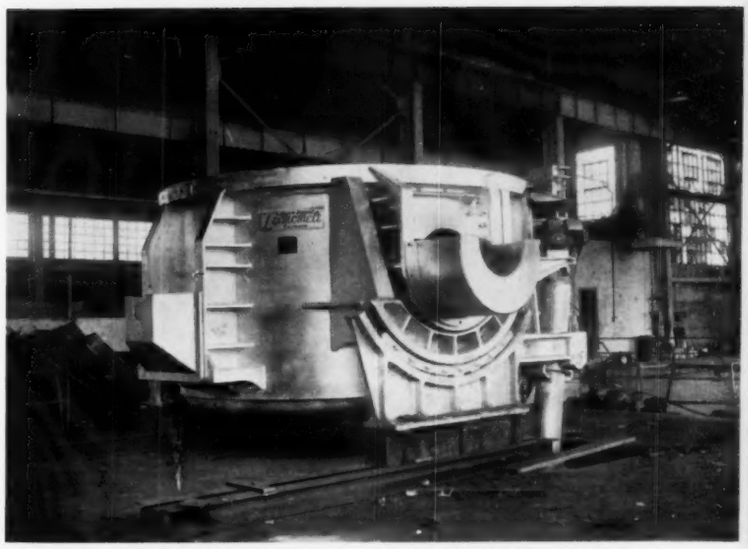
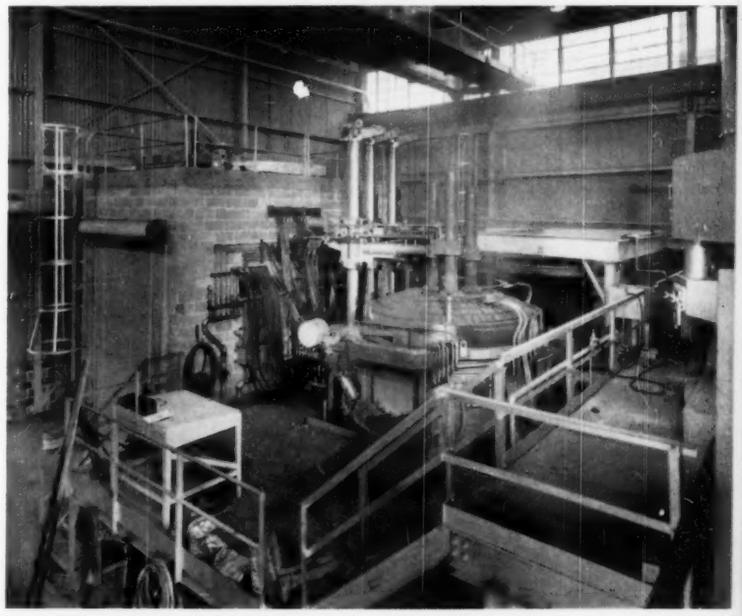


Figure 7 — This roller tilt furnace being built has a 13-ft diam.

Figure 8 — On this nine-ft diam roller tilt iron duplexing furnace, the fixed entry port in the side enables cupola iron to be run in continuously through stationary launderers.



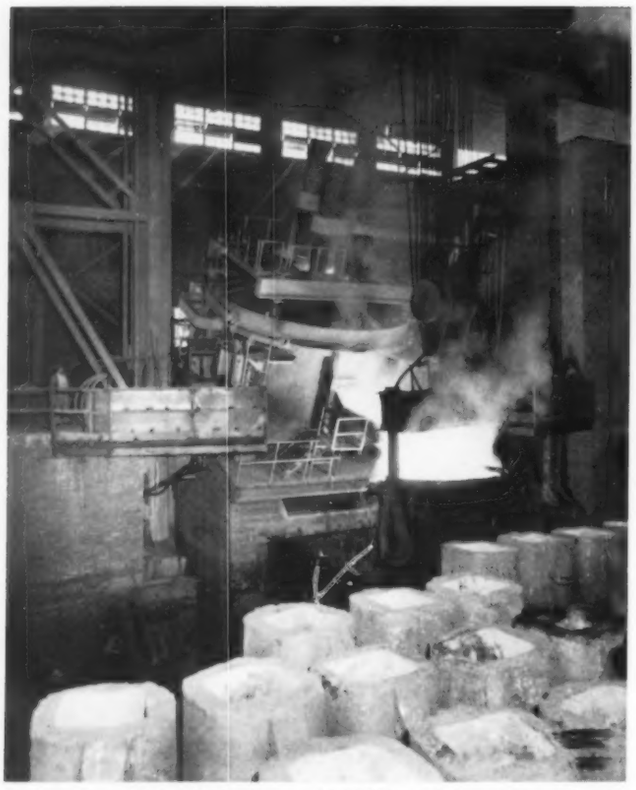


Figure 9 — This 18-ft diam, 18,750-kva furnace is used by Atlantic Steel Co.

Plants also are being put in operation on continuous casting in Argentina, Italy, Australia, Switzerland and Belgium. It is understood the operation is used in Russia.

Continuous casting is carried out by a number of processes. These generally are termed: The Junghans process, the Bohler process, the Cie des Ateliers et Fouges de la Loive (C.A.F.L.) process, the British Iron and Steel Research Association (B.I.S.R.A.) process, the Babcock and Wilcox process, and the Rossi-Junghans process.

Figure 10 — This 20-ft diam 25,000-kva top-charge furnace was placed in operation early in 1957.

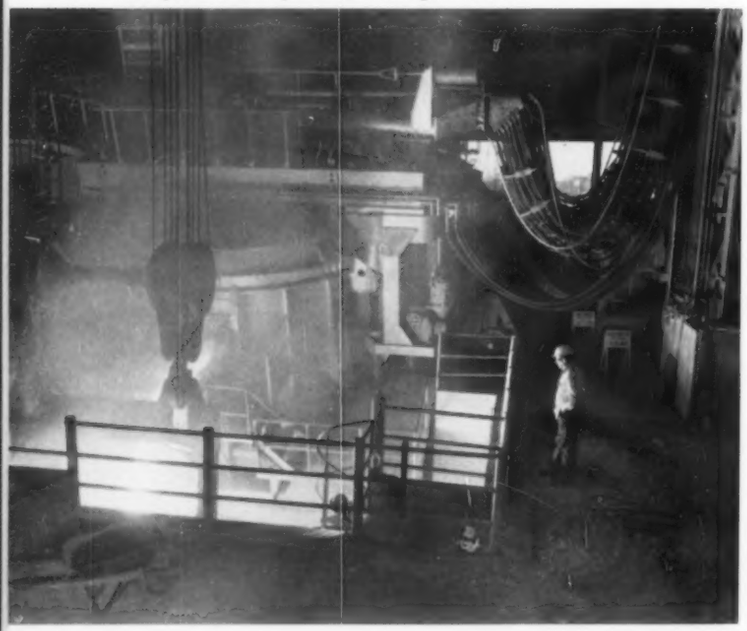


Table IV
Typical Performance Data of an 8-ft Diam Top-Charge Furnace With Oxygen Used to Speed the Heats

Furnace power demand, kva	2700
Tapping temperature, F	3075
Kwhr per ton	432
Electrode consumption, lb	6.6
Heats per roof	400 to 500
Cost roof bricks per ton castings	$0.51
Heats per sidewall	300 to 375
Cost sidewall brick per ton castings	$0.37
Heats per roof 386, 502, 464	524
Heats on linings 387, 403	264
Heats per 24 hr, 22 or 23; sometimes 24	
Average size heat, lb	7800
Pounds per minute tap-to-tap	120
Time power off between heats, min	4.5
Cu ft oxygen per ton melted	186
Melt down carbon, per cent	0.30 to 0.40
Time of oxygen injection, min	2
Carbon drop per minute with $\frac{3}{8}$-in. pipe and 60-psi oxygen pressure	0.081

It would appear that the higher yield of continuous casting could represent a saving of over $6.00 per ton of merchant bars. If we assume only half of this saving obtained and an operation conducted whereby a production of ten tons of bars were made per hr—then the saving would approximate $250,000.00 per yr of continuous operation. This saving should pay for the continuous casting equipment in sufficient time.

USE OF OXYGEN IN MAKING FOUNDRY STEELS

Brief comment on how the use of oxygen can speed up the production of foundry steels probably may be of interest. Table IV gives data on the use of an 8-ft diam furnace running at a 120-lb-per-min rate. When iron ore was used to decarbonize, a speed of 96 lb per min was had. This means a 26 per cent increase in production.

NEW CAPACITY

Some comment, no doubt, should be made as to new capacity to be used in West Coast plants.

In the ingot field, as mentioned, two 25,000-kva, top-charge furnaces for ingots are to go in in Washington State.

A foundry furnace of three tons charge capacity will serve in that same state.

In Oregon one of the major West Coast steel foundries has on order an 8 ft-0 in. inside diameter, top-charge unit.

In the Bay district, a foundry having two electric furnaces will greatly increase its capacity by the installation of the 8 ft-0 in. inside diameter for top-charge size of melting unit. This equipment will be powered with 3125 kva.

Higher powering, it might be commented, is being employed increasingly in the more modern furnaces. For example, seven one-ton usual charge furnaces now under construction will have 800-kva substations. A two-ton usual charge size furnace now being installed will be powered with 1600 kva. An installation of 17 ft-0 in. inside diameter, 50-ton furnace lately has been powered with 20,000 kva and an additional of the furnace same size is to be powered identically.

Another small furnace for West Coast installation is a two-ton usual operating size which will go in in Oregon for iron melting. ▲

PROGRAM

AISE SPRING CONFERENCE

Auspices of Rolling Mill Committee

THE DINKLER-TUTWILER HOTEL
BIRMINGHAM, ALA.

APRIL 21, 22, 23, 1958

MONDAY, APRIL 21, 1958

8:30 am—REGISTRATION—
Mezzanine Floor, The Dinkler-Tutwiler Hotel

9:00 am—ROLLING MILL SESSION—
Dinkler Room

Chairmen: Louis Such, Superintendent Hot Rolling and Cond., Allegheny Ludlum Steel Corp., Brackenridge, Pa.

F. G. Kredel, Chairman, Bar Mill Committee, Republic Steel Corp., Cleveland, Ohio

"Hydraulic Jet Descaling—A New Method to Remove Scale from Hot Steel Ingots, Blooms, Slabs, Billets, and Bars before Rolling," by Benj. G. Harmon, Senior Partner, Harmon and Co., Chicago, Ill., and Robert V. Proctor, Vice President-Engineering, Commercial Shearing & Stamping Co., Youngstown, Ohio

"Mannesmann's New Seamless Mill at Sault Ste. Marie," by Robert Hartenstein, Vice President-Engineering, and Astor L. Thurman, Executive Vice President, Mannesmann-Meer Engineering and Construction Co. Inc., Easton, Pa.

"Republic Strip Facilities in the South," by L. S. Mobley, Chief Engineer, Southern District, Republic Steel Corp., Gadsden, Ala.

9:00 am—ELECTRICAL SESSION—
Ballroom

Chairmen: Robert T. Lucas, Electrical Superintendent, Weirton Steel Co., Div. National Steel Corp., Weirton, W. Va.

C. W. Harrison, Chief Electrical Engineer, Manufacturing Div., Tennessee Coal and Iron Div., United States Steel Corp., Fairfield, Ala.

"Electrical Equipment for a High Speed Annealing Line," by J. E. Butler, Chief Electrical Engineer, Weirton Steel Co., Div., of National Steel Corp., Weirton, W. Va., and Willard G. Cook, Manager of Industry Engineering, Elliott Co., Pittsburgh, Pa.

"A Punched Card Program and Data Logging System for a Tandem Cold Strip Mill," by Orville E. Orbom, Manager, Electro-Mechanisms Dept., Allegheny Ludlum Steel Corp., Brackenridge, Pa., and R. M. Sills, Application Engineer, Steel Mill Engineering, Systems Application Engineering Section, General Electric Co., Schenectady, N. Y.

"Selection and Control of Electrical Equipment for Modern Foil Mills," by Warren Reid, Steel Mill Engineer, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa., and D. E. Abell, Supervisory Engineer, Systems Control Engineering Dept., Westinghouse Electric Corp., Buffalo, N. Y.

2:00 pm—ROLLING MILL SESSION—
Dinkler Room

Chairmen: Charles W. Barrett, District Manager, Southern District, Republic Steel Corp., Gadsden, Ala.

Alfred Krause, Manager Rolling Mills, Steel Div., Ford Motor Co., Dearborn, Mich.

"The Application of Progressive Induction Heating to Forged Roll Hardening Operations," by John M. Dugan, Works Manager and Chief Metallurgist, The Ohio Steel Foundry Co., Lima, Ohio

"Thermit Welding Structural Mill Rolls," by Edward B. Russell, Assistant to Superintendent, Mechanical Shops, Kaiser Steel Corp., Fontana, Calif.

"From Ingot to Ingot in Fifteen Days—Replacing a 27-in. Universal Slabbing Mill with a 38-in. x 66-in. Slabbing Mill on the Same Site," by David Hugh Samson, Project Engineer, Dominion Foundries & Steel, Ltd., Hamilton, Ontario, Canada

2:00 pm—COMBUSTION SESSION—Ballroom

Chairmen: R. A. Lambert, Superintendent, Steam Efficiency and Combustion, Pittsburgh Works, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

David Cousley, Assistant Superintendent-Utilities, Wheeling Steel Corp., Steubenville, Ohio

"Recent Furnace Installations," by O. D. Rice, Vice President and General Manager, and R. W. Ewalt, Sales Manager, Rust Furnace Co., Pittsburgh, Pa.

"Soaking Pits with a High Velocity Combustion System," by David C. Haney, Assistant Superintendent, Fuel and Power Dept., The Youngstown Sheet and Tube Co., Youngstown, Ohio

"Pre-Cast Panel Construction for Furnaces," by R. J. Demaison, Vice President & Technical Director, and E. W. Garvin, Jr., Vice President, Charge Sales, Quigley Co., Inc., New York, N. Y.

TUESDAY, APRIL 22, 1958

9:00 am—ROLLING MILL SESSION—Dinkler Room

Chairmen: R. P. Schuler, Superintendent, Cold Strip Dept., Inland Steel Co., East Chicago, Ind.

W. D. Rees, Superintendent, Bar and Blooming Mill, Lowellville Works, Sharon Steel Co., Lowellville, Ohio

"Rolling of Metals," by J. I. Greenberger, Group Engineer, United Engineering and Foundry Co., Pittsburgh, Pa.

"An Analysis of the Mechanics of Cold Strip Rolling," by Donald Jortner, Allegheny Ludlum Fellow in Mechanical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa.

"Improved Lubrication in Cold Strip Rolling," by J. C. Whetzel, Jr., and Sayre Rodman, Partners, Allegheny Refining Co., Verona, Pa.

9:00 am—MECHANICAL SESSION—Ballroom

Chairmen: Robert W. Holman, Division Chief Engineer, Tennessee Coal and Iron Div., United States Steel Corp., Fairfield, Ala.

A. E. Cichelli, Lubrication Engineer, Construction Engineering Dept., Behlehem Steel Co., Bethlehem, Pa.

"Gear Couplings for Steel Mill Drives," by P. Hollingsworth, Chief Engineer, Fast's Coupling Dept., Metal Products Div., Koppers Co., Inc., Baltimore, Md.

"Maintenance of Back-Up Roll Bearings in Strip Mills," by W. M. Lewis, Master Mechanic, Sheet, Tin and Strip Div., Bethlehem Steel Co., Sparrows Point, Md.

"Automatic Continuous Lubrication of Universal Mill Spindles," by William L. Stover, Assistant Chief Engineer, Mesta Machine Co., Pittsburgh, Pa.

2:00 pm—OFF-THE-RECORD ROLLING MILL PANEL DISCUSSION—Dinkler Room

Moderators: Louis Moses, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.

Don C. Horsman, Plant Superintendent, Continental Steel Corp., Kokomo, Ind.

The following topics will be covered in this panel discussion:

(1) Factors which affect the shape of strip off hot and cold mills.

(2) Roll neck bearing performance on various types of mills (anti-friction, oil film, composition).

(3) Looping and repeating.

(4) Inspection and trimming practices on rod and merchant coils.

7:00 pm—INFORMAL STAG DINNER—Combined Dinkler Room and Ballroom

Speaker: N. C. Michels, Vice President of Engineering, Tennessee Coal and Iron Div., United States Steel Corp., Fairfield, Ala.

WEDNESDAY, APRIL 23, 1958

8:30 am—INSPECTION TRIP—

Republic Steel Corp., Southern Steel District, Gulf Steel Works, Gadsden, Ala. Buses will leave from The Dinkler-Tutwiler Hotel.

Spring Conference Chairmen

LOUIS SUCH | F. G. KREDEL | ROBERT T. LUCAS | C. W. HARRISON | C. W. BARRETT | ALFRED KRAUSE | R. A. LAMBERT

DAVID COUSLEY | R. P. SCHULER | W. D. REES | ROBERT W. HOLMAN | A. E. CICHELLI | LOUIS MOSES | DON C. HORSMAN

Abstracts of Technical Papers

to be presented at technical sessions of

AISE SPRING CONFERENCE

April 21, 22, 23, 1958

THE DINKLER-TUTWILER HOTEL BIRMINGHAM, ALA.

"HYDRAULIC JET DESCALING—A NEW METHOD TO REMOVE SCALE FROM HOT STEEL INGOTS, BLOOMS, SLABS, BILLETS, AND BARS BEFORE ROLLING"

by BENJ. G. HARMON, Senior Partner, Harmon and Co., Chicago, Ill., and ROBERT V. PROCTOR, Vice President, Engineering, Commercial Shearing & Stamping Co., Youngstown, Ohio

B. G. HARMON

△ FORCED to furnish forgings free from scale pits and embedded scale to retain patronage of one of its largest customers, an entirely new method of hydraulic descaling was developed. This method was so successful that we were urged to furnish it for the forging industry. Models of different types and sizes were developed. Over 59 of these descalers were sold to both custom and captive forge plants, not only in the United States, but also in Great Britain, France, Italy, Sweden and Australia.

Instead of employing spray nozzles for spraying high pressure water on the hot, crusty surfaces of the steel billets and bars, the descaler employs a jet ring This enables the high pressure water to be delivered in a conical sheet of narrow width, with much greater descaling efficiency.

R. V. PROCTOR

The water required by the ring is very much less than the water used by spray nozzles. The steel is therefore hotter for forging.

Because of the success, the jet ring achieved in descaling billets and bars in the forging industry, it was suggested that the steel industry would be interested in this new type descaler.

This led to the development of the jet bar for descaling flat products.

To get started in the steel industry, without interfering with production of a large and expensive hot strip mill, it was suggested that hydraulic-jet descaling be tried in the Applied Research Center of the United States Steel Corp. at Monroeville, Pa.

Shortly thereafter, Monroeville's engineers found scale was giving erratic results in one of their rolling research projects. At their urgent request, a hydraulic jet descaler was hurriedly thrown together for their temporary use. This descaler took the scale off. The research project was successfully completed and reported at the AISE Spring Meeting in 1957 under the title "Turn Up and Turn Down in Hot Rolling." (Editor's note. See this issue.)

Monroeville retained this descaler 15 months to descale slabs and plates up to 12 in. wide. The Monroeville installation furnished the additional information needed to tailor hydraulic jet descalers to the steel mills. These descalers are now being offered for continuous and semi-continuous hot strip and plate mills, as well as for billet, bar and seamless tube mills.

The paper covers the variables that must be most carefully considered in tailoring the design of each descaler to best fit its particular location in a steel mill.

"MANNESMANN'S NEW SEAMLESS MILL AT SAULTE STE. MARIE"

by ROBERT HARTENSTEIN, Vice President—Engineering, and ASTOR L. THURMAN, Executive Vice President, Mannesmann-Meer Engineering and Construction Co., Inc., Easton, Pa.

ROBERT HARTENSTEIN

△ THIS mill in its conception and long range planning is as fully automatic as any such operation can be; from receiving the incoming billet to the delivery of the finished pipe, the electrical equipment has been co-ordinated with the mechanical operations in such a way that when the mill is completely installed and is in full production on fully automatic operation, it will be possible to

deliver finished pipe, threaded, with coupling, tested and oiled to the receiving skids in the shipping floor all as a co-ordinated series of completely automatic operations on a single piece of metal. Not all of the equipment is yet installed to obtain this complete automation, but the mill has all been planned for this type of operation.

A. L. THURMAN

The incoming billet will be automatically cut to a predetermined length by cutting torch in the billet cutting department, and from that point the billet will be paced through a series of operations, the next of which is the weighing and recording of the billet weight. It will then be delivered to the billet furnace, heated to 2250 F, hot centered, pierced, elongated, rolled to length, reeled, sized, weighed and measured, and cooled. Then as a cold pipe it will be straightened, gaged by x-ray, inspected, cut off on both ends, threaded on both ends, delivered to the tester field where a coupling is put on one end, drifted, tested, weighed, measured, stencilled, oiled and delivered to shipping racks. This was the first seamless tube mill in the world on which such complete automatic operation has been attempted.

In instituting automation into the conventional seamless tube mill process, it was not the thought that automatic operation could in all cases, especially on the small end of the size range, improve upon the possible manual production rate on a short time basis; rather the intention was to make a gain on the long-term basis at a continued high production rate over an 8-hr period, by the elimination of the element of operator fatigue. With automation in full command, the effect of operator fatigue should be eliminated, and combined with the very worthwhile by-product of decrease in operator errors, a substantial gain in pieces per 8-hr turn, even on the smaller sizes, should result. In handling the larger sizes, of course, the same principles apply, but even greater gains should be expected from the elimination of the fatigue factor.

Unique to this mill also is the concept of an extremely fast schedule change, the design of all mill components being such that a complete schedule change from say an extreme of $4\frac{1}{2}$ to $10\frac{3}{4}$ in. should be possible in less than an hour. To accomplish this, new outlet table designs, fully motorized, were developed for both piercing mills and reelers, and entirely new designs were necessary for the plug mill and the sizing mill. No mill of any kind in the world was ever built which embodied so many new concepts by comparison with existing mills. It was a bold step forward to attempt so many departures from conventional designs, but the designers and builders of this mill equipment, Mannesmann-Meer, and especially The Mannesmann Tube Co. operators were not satisfied with the results which could be expected from old, conventional designs.

"REPUBLIC STRIP FACILITIES IN THE SOUTH"

by L. S. MOBLEY, Chief Engineer, Southern District, Republic Steel Corp., Gadsden, Ala.

△ THIS paper describes the installation of new flat-rolling facilities at the Gadsden, Ala. plant of Republic Steel Corp. —a major construction job of more than two years duration. The program resulted in the replacement, with modern equipment, of the plant's old hand sheet mills and single galvanizing pots.

L. S. MOBLEY

The author reports on improvements made on existing installations, such as the blooming mill and plate mill, and describes in detail the new units which include a four-stand, four-high hot strip mill; a pickle line; a three-stand, four-high tandem cold reducing mill; an annealing department; a single stand, four-high temper mill; and a continuous galvanizing line.

The paper touches upon the problems encountered in placing new installations while keeping existing equipment in production insofar as possible.

The flat rolled expansion, coupled with an increase in ingot capacity, has resulted in a plant at Gadsden which is now in position to meet increased demands for hot and cold rolled strip in sheets and coils and galvanized sheets and coils.

"SELECTION AND CONTROL OF ELECTRICAL EQUIPMENT FOR MODERN FOIL MILLS"

by WARREN REID, Steel Mill Engineer, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa., and D. E. ABELL, Supervisory Engineer, Systems Control Engineering Dept., Westinghouse Electric Corp., Buffalo, N. Y.

WARREN REID

△ THE growing use of foil in the packaging industry has resulted in considerable expansion of the facilities for rolling aluminum foil. The aluminum foil mill is in some respects similar to a single stand cold mill in the steel industry, however, there are certain differences which affect the selection and control of the electrical equipment for the foil mill. The extrusion effect and the range in draft in the mill stand require careful attention when selecting the reel motor speeds and the ratio of the associated gear unit. Reel inertias encountered are such that mill accelerating times are usually somewhat longer than those in the steel industry. Many so-called foil mills could be more aptly identified as combination sheet and foil mills, and as such require operation over extremely wide ranges of tension. This requirement often leads to reel arrangements which have the provision for multi-motor drives and/or multi-gear ratio selections.

D. E. ABELL

In addition to providing the normal protective features, the control equipment for the main stand of an aluminum foil mill is designed to maintain a uniform accelerating

or decelerating rate, to maintain a constant generator voltage under normal operating conditions and to permit an emergency stop in a minimum time. The control of the reels is designed to control the reel current and voltage in such a manner as to maintain essentially constant strip tension. The purpose of the control equipment for the foil mill is thus similar to that for the single stand cold mill for steel, however, the thin aluminum foil and the special reel drive arrangements increase the necessity for highly accurate regulators. Some foil mills, presently designed, will be equipped with automatic gage control. These mills will use a foil thickness gage whose output controls the mill speed and/or strip tension in such a manner as to maintain "on gage" material. It is expected that automatic gage control will be considered as a standard control feature in the years to come.

"A PUNCHED CARD PROGRAM AND DATA LOGGING SYSTEM FOR A TANDEM COLD STRIP MILL"

by ORVILLE E. ORBOM, Manager, Electro-Mechanisms Dept., Allegheny Ludlum Steel Corp., Brackenridge, Pa., and R. M. SILLS, Application Engineer, Steel Mill Engineering, Systems Application Engineering Section, General Electric Co., Schenectady, N. Y.

O. E. ORBOM

R. M. SILLS

Δ THIS paper describes the design and construction of a punched card programming and data logging system for a tandem cold strip mill.

The paper discusses how the requirements for such a system were established, how they were met, and the expected benefits to be derived from use of the system.

Also discussed are problems encountered in the design and their solution.

"THE APPLICATION OF PROGRESSIVE INDUCTION HEATING TO FORGED ROLL HARDENING OPERATIONS"

by JOHN M. DUGAN, Works Manager and Chief Metallurgist, The Ohio Steel Foundry Co., Lima, Ohio

J. M. DUGAN

Δ UNTIL recent years, the conventional method for hardening forged work rolls used in tandem and temper mills has consisted of heating entire body section of roll to an austenitizing temperature followed by a drastic water quench treatment, after which rolls received a low temperature stress relief treatment. Rolls of this type are made in compositions which will provide a martensitic surface area when subjected to above described treatment. During the last three years, rolls have been placed in service in many cold mills in the United States which have been heated for hardening quench by a progressive electric induction method.

In this paper, a comparison of results of conventional heat-treating methods with results obtained with progressive induction method is made.

In order to obtain adequate hardness values in the work surface of cold mill rolls by conventional heat-treating methods, the quenching treatment must be so drastic that severe stress conditions must result. There have been many instances of roll breakage due to quenching stresses in production and sometimes even in mill service.

Experiments were made attempting to develop a method for heating the surface area alone to a temperature above the austenitizing range, while maintaining the inner portions of the roll below transformation temperatures. Efforts to do this with any known type of fuel burner were unsatisfactory. Methods developed in Belgium and in Germany to heat the work surface area of cold mill rolls to quenching temperatures with electric induction method are described.

Electric induction heating principles are reviewed and the adaptation of the induction heating principle to roll heat treatment is developed. The effect of induction heating on the microstructure and macrostructure of roll forgings is compared with the structures provided with the conventional heat-treating methods.

One section of the paper is devoted to the description of a low cycle induction annealing method for tempering used cold mill rolls which are to be rehardened for further mill service. Induction heating is particularly suited for this operation because, by this method, possibility for neck warpage during rehardening process can be completely eliminated. The paper also contains certain information concerning service life of various types of cold mill rolls.

"THERMIT WELDING STRUCTURAL MILL ROLLS"

by EDWARD B. RUSSELL, Assistant to Superintendent, Mechanical Shops, Kaiser Steel Corp., Fontana, Calif.

E. B. RUSSELL

Δ THIS paper is written with the intent of giving a clear picture of the various steps involved in the application of a thermit weld to replace broken wobblers on the roll necks of various structural mill rolls used for rolling the shapes involved in producing structural steel members.

After a brief history of the discovery of the thermit reaction, a chronological discussion of the necessary steps is maintained in proper sequence illustrated with slides of an actual weld being prepared from start to finish.

Interspersed through this description are charts, diagrams, sketches and practical hints of value to those already engaged in or familiar with thermit welding procedures.

While no attempt is made to cover the entire field of thermit welding, still a considerable amount of the data

given is applicable in one form or another to all thermit welding problems.

Preparation of joints, alinement and problems of expansion and contraction are touched upon as well as comparison between conventional wax molding methods vs. wood or metal pattern uses.

Particular emphasis is given to the many small details, usually not apparent to the bystander, which, if neglected, will mean failure in producing satisfactory thermit welds.

Also touched upon are the hazards associated with this type of welding and a short discussion of particular safety precautions which should be taken.

"FROM INGOT TO INGOT IN FIFTEEN DAYS—REPLACING A 27-IN. UNIVERSAL SLABBING MILL WITH A 38-IN. X 66-IN. SLABBING MILL ON THE SAME SITE"

by DAVID HUGH SAMSON, Project Engineer, Dominion Foundries & Steel, Ltd., Hamilton, Ontario, Canada

D. H. SAMSON

△ THE project involved the progressive replacement of an existing 2-high hot mill, approach and runout tables and all drives and auxiliaries while the mill operated at normal production level.

The only major shutdown of the project was at the end of the program when the old mill and pinion stand were replaced with the new mill and pinion stand in the same location, but on new foundations. This was accomplished in a 15-day shutdown, after 12 months of preliminary work and planning. The highlights of the 15-day shutdown included installation of the new mill foundation in 36 hr from finished excavation to finished pour, and the setting of the new mill on its site in 30 hr.

In the months of work before the 15-day shutdown, careful planning instead of mill shutdown was the order of the day. Major items installed without an extended mill shutdown included the mill approach and runout tables, scale pit and flushing system, the new 6000-hp main motor-generator set, the 5000-hp main drive motor, and 90 per cent of all new switchgear and auxiliary electrical equipment. With the exception of the switchgear, all of this equipment was put into service with the old mill so that a complete checkout was made ahead of the mill changeover.

Any "downtime" required came on the regular weekly 8-hr mill maintenance period. In some cases, the period was extended to 12 or 16 hr and occasionally to 24 hr.

"RECENT FURNACE INSTALLATIONS"

by O. D. RICE, Vice President and General Manager, and R. W. EWALT, Sales Manager, Rust Furnace Co., Pittsburgh, Pa.

△ THE growth of the steel industry over the last fifteen years has brought about many changes in the design and construction of heating equipment for rolling mills. This presentation is restricted to three of these, namely, soaking pits, billet reheating and slab reheating furnaces.

Recently, to prevent downtime on a bar mill, a new reheating furnace was completely erected on rollers adjacent to the old furnace it was to replace. Normally, the erection of a furnace of this size would take approximately three months. After the furnace was erected on these rollers, the mill was shut down, the old furnace dismantled, foundation work done and the new one rolled into place with a downtime on the mill of only twenty-one days. A portion of this paper is devoted to the description of the furnace, the methods used to erect it and move it into place, along with available slides.

R. W. EWALT

The desire for quality heating, maximum capacity in available space and the utilization of a low Btu fuel recently dictated the design and construction of 16 holes of regenerative soaking pits. These pits are arranged in batteries of two holes each. Each pit has primary checkers at the base of the downtakes on either side and secondary checkers located at the base of remotely located ejector type stacks. They are completely modern as to temperature and combustion control, and are equipped with automatic reversal systems. A portion of this paper is devoted to a description of the pits along with pictures and slides.

Strip mill capacity has increased so greatly that the reheating equipment originally installed has been found inadequate. The final portion of this paper is devoted to a description, with slides of a recent modernization job on reheating equipment in a modern mill. The modernization consists of increasing the inside width of the furnaces without increasing their over-all width, addition of extra heating zones so that the heat is properly applied and utilized, and the addition of extra recuperators for heat recovery. Unusually high heating rates in pounds per square foot of hearth covered were the result, and capacity was increased to the requirements of the mill, with furnaces occupying the same area as formerly.

"SOAKING PITS WITH A HIGH VELOCITY COMBUSTION SYSTEM"

by DAVID C. HANEY, Assistant Superintendent, Fuel & Power Dept., The Youngstown Sheet and Tube Co., Youngstown, Ohio

D. C. HANEY

△ THE author describes the Youngstown Sheet & Tube Co.'s new installation of soaking pits at the Brier Hill Works, Youngstown, Ohio.

The installation consists of two 3-hole rows of one-way top-fired soaking pits with one metallic recuperator per row. The factors influencing the decision to use this type of design and construction were as follows:

1. The possibility of obtaining the greatest possible soaking pit area dictated the installation of one-way top-fired soaking pits.

2. The advantage of considerably lower installation cost favored soaking pits without the usual basement construction needed for the dumping and handling of refuse with coke breeze bottom practice.

3. Investigation of high-speed quality heating as well as successful dry bottom practice developed the need for a high velocity combustion system.

4. Available building space, ease and cost of soaking pit maintenance, as well as the need for combustion air at higher pressure to the burners made the use of metallic recuperators expedient.

The paper concludes with a review of problems and performance during the first year of operation.

"PRE-CAST PANEL CONSTRUCTION FOR FURNACES"

by R. J. DEMAISON, Vice President & Technical Director, and E. W. GARVIN, JR., Vice President, Charge Sales, Quigley Co. Inc., New York, N. Y.

R. J. DEMAISON

△ A colored moving picture will be shown indicating the complete erection of a car bottom furnace using patented pre-cast insulating refractory panels assembled to prefabricated steelwork with all bolted construction, resulting in a type of thin wall individually supported furnace lining.

The continuity of the film shows the various phases of the steel erection and the installation of light weight insulating pre-cast panels, and especially designed pre-cast external individual flues.

E. W. GARVIN, JR.

One important feature to be noted from this is that with simple and maximum shop prefabrication and minimum field erection, speed of erection is accomplished at lowest possible cost.

A brief summary will be rendered reevaluating all the various figures and indicating efficiency of operation.

"ROLLING OF METALS"

by J. I. GREENBERGER, Group Engineer, United Engineering and Foundry Co., Pittsburgh, Pa.

J. I. GREENBERGER

△ THE historical development of the 2-high, 3-high, 4-high and cluster mills is reviewed with particular emphasis paid to mill rigidity.

Various factors involved in the basic rolling process are explained in detail. Work roll size selection for both hot and cold rolling applications and the related effects of roll flattening, the geometrical $\frac{\mu L}{T}$ factor and roll pressure limitations are covered. Rolling characteristics of the material being rolled also affect proper mill selection and recommended rolling practice. The effect of rolling speed on the coefficient of friction is discussed and a relationship suggested for the material temperature as affected by speed of rolling.

Use of power curves by the mill engineer is reviewed and a suggested modification to increase their usefulness is offered. Some apparent contradictions when rolling aluminum and magnesium are discussed.

Typical rolling practice for producing tin plate or sheet product from the original ingot form is followed in detail. Types of slabbing mills, hot mills, cold mills and temper mills, and their typical productivities are analyzed. In certain rolling operations, practice is established by metallurgical limitations and demands.

Parallel developments and advances in instrumentation, electrical controls, bearings, lubricants, etc., have contributed materially to recent rapid studies in rolling of metals.

"IMPROVED LUBRICATION IN COLD STRIP ROLLING"

by J. C. WHETZEL, JR. and SAYRE RODMAN, Partners, Allegheny Refining Co., Verona, Pa.

J. C. WHETZEL, JR.

△ IMPROVEMENT of lubrication efficiency in cold strip rolling, or, a decrease in friction between rolls and strip will lower rolling pressures for a given strip reduction as well as increase the amount of possible reduction. If lubrication can be improved, also, higher speeds of rolling can be obtained. The effect of improved lubrication will be greatest in critical thin strip rolling, such as the production of tin mill black plate.

This paper describes results obtained from a small rolling mill operated for lubricant research. By rolling thin strip under controlled pressures, speeds and reductions, using various lubricants, the performance of these lubricants has been examined in detail. Also, many methods and temperatures of application of lubricants have been explored. The majority of this work has been concerned with fatty oils and their use on high-speed tandem mills. Although incomplete, this research, to date, has yielded several tentative theories on rolling lubricant behaviour and suggests methods whereby improvement may be effected.

SAYRE RODMAN

The extent of friction between rolls and strip appears to depend on the thickness of oil layer present in the roll bite during actual strip reduction. Friction is reduced and better lubrication afforded as this amount of oil is increased, up to certain limits. At low rolling speeds, more oil offers little improvement. At higher speeds the improvement is progressive, up to the point where thicker films will not enter the roll bite. Also, with comparable oil films, friction decreases with an increase in rolling speed.

By regulating the amount of oil on the strip or rolls,

friction can be well controlled to a level appropriate to the rolling job. However, to broaden the range of lubrication improvement or control, oils capable of sustaining thicker films, where necessary, must be available. The authors believe this may be achieved by the use of fatty oils of higher viscosity which have better properties in this respect.

"AN ANALYSIS OF THE MECHANICS OF COLD STRIP ROLLING"

by DONALD JORTNER, Allegheny Ludlum Fellow in Mechanical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa.

DONALD JORTNER

Δ A THEORY is developed to analyze the conditions between the rolls and strip in cold rolling. The theory takes into account the elastic deformations of the strip and the rolls and the effect of applied tensions, as well as the plastic strip deformation. The end result of this analysis is to predict the load and power requirements of a given rolling mill for any specified strip material and dimensions. The method applies to any strip material or roll material whose elastic properties can be measured.

The results of the theory are compared to a series of experimental results in order to determine limits on the accuracy of the theory. Other information obtained from the theory include the pressure distribution between the rolls and strip, the maximum pressure, shape and length of the arc of contact, and the amount of "roll flattening" for any given case.

Finite difference methods are used throughout the solution, and the computations are performed on an IBM 650 digital computer. The computer program which has been developed requires only the insertion of the dimensions and the elastic-plastic properties of the system to obtain a solution. No empirical correction factors are used. The method of solution is a successive approximation procedure which converges to an equilibrium state of stresses and deformations.

The theory may also be used in reverse, i.e. the minimum gage obtainable without exceeding a given load can be found. Also, the theory has application in the investigation of the causes of non-uniform strip gage and roll fatigue failure.

"GEAR COUPLINGS FOR STEEL MILL DRIVES"

by P. HOLLINGSWORTH, Chief Engineer, Fast's Coupling Dept., Metal Products Div., Koppers Co. Inc., Baltimore, Md.

P. HOLLINGSWORTH

Δ GEAR-TYPE couplings have been used in steel mill drives for over thirty-five years. The shafts they have connected in these applications range from a fraction of an inch to 32 in. in diam. In addition to the common, close-coupled, full-flex design, manufacturer's variations of standard designs have also been provided. Among the variations noted are: limited end float, overload protection, long slide, floating shaft arrangements, and continuously lubricating. The gear-type spindle coupling, which provides for wide angle misalinements, is one of the more recent innovations.

Gear-type spindle couplings have been made practical by the development of tooth forms that allow wide angle engagement of the mating gears with minimum blacklash and acceptable gear contact. Additional refinements include means of retaining lubricant and methods of quick disconnect. Special materials and material treatments also have been developed to compensate for the severe space requirements of many roll drive applications. Gear-type spindle couplings have also been provided with overload protection, long slide, and other features. Many of these couplings are used today to replace other types of spindle couplings. The difficulties of such replacements are discussed.

The importance of care in selecting and specifying the proper coupling for the proper application is stressed. The dependability of gear-type couplings is supported by the fact that many of them have been in continuous service for over twenty-five years.

"MAINTENANCE OF BACK-UP ROLL BEARINGS IN STRIP MILLS"

by W. M. LEWIS, Master Mechanic, Sheet, Tin & Strip Div., Bethlehem Steel Co., Sparrows Point, Md.

W. M. LEWIS

Δ THIS is a practical discussion in which the author details the successful methods of bearing maintenance used at the Sparrows Point Plant of the Bethlehem Steel Co. Some contributing causes for poor bearing life are also discussed.

The discussion of the subject deals primarily with babbitted bearings as applied to straight neck back-up rolls. Special attention is given to the following:

1. Journals (roll necks).
   (Surface requirements and how requirements are met.)
2. Neck etching.
   (Causes and remedies.)
3. Bearing seals and shields.
   (Type seals, fits, etc.)
   (Shielding methods used.)
4. Various factors that contribute to excess bearing maintenance.
5. Assembly of bearings on roll necks.
   (Care and method used.)
6. Babbitting of bearing shells.
   (Detailed description of puddling method.)
7. Machining and scraping.
   (Fits, tolerances, etc.)
8. Carbon build-up.
   (Removal and effect on bearing life.)
9. Bearing oil.
   (Requirements for good bearing and neck life.)
   (Cleaning and filtering methods.)
10. Aluminum sleeve bearings.
    (Brief discussion based on limited experience.)

"AUTOMATIC CONTINUOUS LUBRICATION OF UNIVERSAL MILL SPINDLES"

by WILLIAM L. STOVER, Assistant Chief Engineer, Mesta Machine Co., Pittsburgh, Pa.

W. L. STOVER

△ RECENT improvements have been made in the continuous lubrication of the bearing segments of universal mill spindles. This paper will deal mainly with three different designs now in use, two of which were very recently installed. These are:

1. Direct spray to the outside of the coupling joint.
2. Oil injection into air, fed internally to the bearing segment faces.
3. Oil mist fed internally to the bearing segment faces.

The second and third designs require the use of stationary collars around the couplings or spindles, properly sealed so that the lubricant can be fed through the stationary collar into the spindle or coupling head, then to the bearing segments. In this manner the pumping station can be mounted on the floor, and the lubricant introduced continuously, or on a controlled time cycle, as desired.

Since these systems are not dependent upon the rotation of the mill spindles, they will work equally as well on nonreversing mills, as well as reversing mills. Speed seems to be the only critical factor as this affects the life of the seals in the rotating collar.

Many advantages of these systems are obtained as a by-product of improved lubrication. These, of course, were expected and that is why there have been many requests for improved lubrication of mill spindles since the advent of centralized lubricating systems.

Remember the Inspection Trip!

REPUBLIC STEEL CORP.

GADSDEN, ALA.

April 23, 1958

The Dollars and Sense of Pickle-Liquor Treatment

by James S. Joseph
Sales Engineer
and E. T. Culver
Process Engineer
Koppers Co., Inc.
Engineering and Construction Div.
Chemical Dept.
Pittsburgh, Pa.

. . . . four processes are in commercial operation today which provide simple and direct solutions to waste pickle liquor disposal problems . . . . best process to be used depends on location and local conditions and the amount of pickle liquor to be processed . . . .

VINEGAR was once the best known acid for removing oxide scale from steel. Thus the term pickling. The treatment required several days but must have otherwise been quite satisfactory. Certainly there was no concern with the disposal of the residue. Today steel can be pickled at a rate of a ton a minute, but the acid waste resulting from the process creates increasingly serious pollution problems. During periods of near maximum productivity, about 50,000,000 tons of steel are pickled per year. In 1956, steel companies purchased 1,300,000 tons of acid for pickling alone, resulting in over 1,000,000,000 gal of spent acid solution. Most of this liquor was disposed of at practically no cost merely by discharging it to a nearby waterway. In the very near future, steel producers, both large and small, will find it expedient if not necessary, to take stock of their disposal problems and evaluate the many processes reported in the literature and described in patents. It is intended that this paper will help orient the thinking of those persons responsible for plant-waste studies and help by-pass detailed engineering studies of processes which in the long run cannot possibly prove economical for a particular situation.

For years, chemists have looked for ways of turning pickling waste into a profitable by-product, but almost all engineers have concluded that this is an ideal more to be wished for than hoped for. Either raw material for pickle liquor, iron and sulphuric acid, costs only a few cents per pound, and only under most unusual circumstance can the regeneration of these raw materials be achieved at a profit. The processing of waste pickle-liquor, therefore, is undertaken only where necessary to avoid stream pollution, and the selection of a process reduces itself to finding the cheapest possible means of rendering the waste to a harmless or useful form. Neutralization can be effected for two to four cents per gallon of waste solution. Since the size of the installation is a major cost factor, community contractors for disposal have been able to show lower costs than can be obtained by isolated small processors. Regeneration of the waste liquor can be performed at less cost in large installations, and installations of this type are now in successful operation.

PICKLING TECHNIQUES

Selection of the process for a given installation must be governed at least in part by the pickling operation itself, and therefore a brief review of the various methods of pickling is appropriate.

Steel is pickled either batchwise or continuously depending on its semi-finished form. Wire, rod, pipe, sheet and such similar forms can only be pickled as units or groups of units. In the simplest method of pickling, bundles, coils or baskets of scale- or rust-encrusted steel are immersed in a vat of dilute sulphuric acid for a length of time sufficient to remove the scale while keeping direct acid attack on the steel to a minimum. The various factors such as temperature, agitation, acid concentration, inhibitors, etc., affecting the speed of pickling are complicated,[1]* but need not be considered here in detail. The operation is characterized by a constant decrease of acid strength with a resulting increase in pickling time. This effect can be controlled temporarily by the periodic addition of fresh acid up to the point where ferrous sulphate starts to precipitate and the batch must be dumped. This method can permit very efficient use of acid, but the length of pickling time involved (as long as 30 to 50 min) is much greater than for other systems. A modification of this process provides several vats in series serviced by automatic or semi-automatic hoisting equipment arranged to dip the work in baths of decreasing acid strength and ending with one or two rinse baths. At the cost of a more complicated installation, it is possible to control

* Numbers refer to Bibliography at end of article.

acid attack by contacting the heaviest scale with the strongest acid and providing a clean-up dip in a weaker solution. Nonetheless, constantly changing bath conditions require skilled operator attention for proper control of pickling.

Truly continuous pickling is possible only in the case of strip, sheet or black plate which comes from the hot mill in coil form. To permit a constant flow of material through the baths, the end of each succeeding coil is welded onto its predecessor, and the strip is sheared at the finish end of the pickling line to start a new coil. Older continuous lines employed a single acid-bath followed by one or more rinse baths. Newer installations employ several vats in series with provision for flow of acid countercurrent to the flow of steel. Thus, the freshest acid gives a final polishing to the cleanest steel and the most readily-attacked scale makes the best use of the spent acid leaving the bath. The latter method provides for the most efficient acid usage and the most uniform pickling of the work. Continuous picklers operate at speeds from 50 to 400 fpm, and the total time of immersion may range from half a minute to five minutes depending on the type of steel pickled and the chemical and mechanical composition of the scale. These short reaction times are possible only at the expense of increased acid consumption. Whereas solutions from batch picklers can often be discharged at a free acid strength of one to two per cent, the liquor from a continuous machine will seldom contain less than 7 per cent sulphuric acid, a value which not only represents an immediate material loss but also numerous disposal problems.

Both batch and continuous methods are used for various alloy and nonferrous metal pickling. In addition to the sulphuric bath, stainless steels are frequently cleaned in nitric acid mixed with hydrochloric or hydrofluoric acid. Not only does this multiplicity of reagents compound the disposal problem, but also it may complicate the picture by reason of the presence of alloying metals in the effluent. Copper, zinc, nickel, cadmium and chromium are all toxic materials, and their discharge to waterways will, in time, be severely curbed.

Hundreds of processes have been proposed for pickle-liquor treatment; more papers and patents have been published on pickle-liquor treatment than any other problem of waste disposal except sanitary sewage. The seemingly impossible task of becoming educated in the field is not so difficult when the subject is broken down into logical sub-sections and the various methods grouped for direct comparison. For instance, all treatments may be divided into two general types, destructive or regenerative. Either the spent liquor is to be safely destroyed and legally disposed of, or part or all of it is to be regenerated and reused.

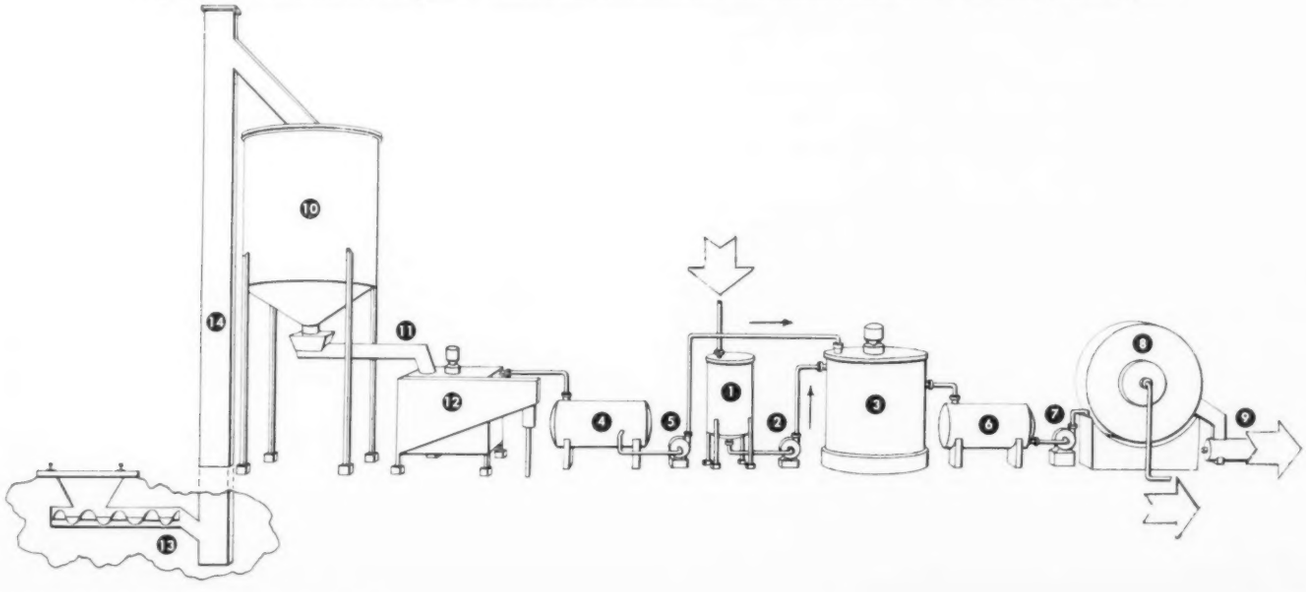
NONREGENERATIVE PROCESSES

Of the destructive processes, only two have stood the test of time, and there appears to be no new theoretical approach which is likely to change this picture in the near future. Neutralization with lime is, of course, an old standby. Though there are many variations in details of operation, the process has a universal similarity of application.

Batch neutralization—The chemistry is quite simple, being generally illustrated by the equation $FeSO_4 + H_2SO_4 + 2\ Ca(OH)_2 \rightarrow Fe(OH)_2 + 2\ CaSO_4 + 2\ H_2O$. The reaction products are relatively insoluble and after filtration the clear effluent is generally considered acceptable for discharge to clean streams.

Small volumes of pickle liquor are easily handled in the batch-treatment plants, while volumes over 10,000 gal a day are processed more conveniently in a continuous operation. The batch process requires only a mixing tank, circulating pump and bag-lime storage and handling facilities. The mixing tank should have about 10,000 gal working capacity. Sufficient lime is slaked in the tank and the proper volume of spent liquor is added while circulating the slurry through a mixing eductor located in the bottom of the tank. The free acid is neutralized instantaneously on being mixed with the lime thus eliminating the necessity for using stainless-steel equipment. In order to precipitate the ferrous hydroxide, the pH must be raised to approximately 9.3. The time required for this reaction depends on the purity of

Figure 1 — Schematic diagram illustrates continuous lime-neutralization of spent pickle liquor.



the lime, the temperature of the solution and various other operating conditions. A representative cycle for treatment of 5000 gal of waste pickle liquor might be as follows:

	Hours
Water addition	1.5
Lime addition	2.5
Slaking	0.5
Waste-liquor addition	1.5
Precipitation	1
Settling	4
Sludge discharge	1
Total	12

Ordinarily, no provision is made for dewatering the sludge by any means other than decanting supernatant liquid off the mixing tank. The pump used to slake, recirculate and discharge sludge must be capable of handling a high solids-content fluid. The resulting neutral, inert waste may be pumped to a tank car or truck for disposal elsewhere, e.g., a nearby abandoned mine or slag dump.

Continuous neutralization—Continuous operation requires only mechanization of the manual operations. The use of bag lime for volumes of spent liquor over 10,000 gal a day is unwieldy and it is, therefore, common that bulk lime be purchased and stored in a silo adjacent to the neutralizing facilities. The same chemical and operating principles used in the batch process are also applicable to continuous lime-treatment (Figure 1). Spent pickle liquor from a holding tank (1) is metered with a feed pump (2), to the mixing section of the neutralization tanks (3), where it is thoroughly mixed with a calculated quantity of milk of lime or its equivalent from the lime slurry tank (4) and pump (5).

The pH of the solution is maintained at a value sufficiently high to protect the steel portions of the equipment from acid attack. The time required for ferrous sulphate to be converted to ferrous hydroxide depends on the specific neutralizing agent used. In the case of high-calcium lime, forty-five minutes is more than adequate to reach a pH of 9.3, the point at which essentially all the iron is removed from solution.

The slurry containing about 10 per cent solids overflows to a sludge pumping tank (6) after which it may receive a variety of treatments. The simplest method is to pump it to a nearby lagoon where the solids are permitted to settle out while the supernatant, clear, neutral liquid drains to the sewer. If a natural lagoon is not available, settling tanks may be provided for clarification, and the dewatered sludge is then removed in tank cars or trucks for disposal on a slag dump or other disposal area.

Where space is at a premium, it is common practice to pump (7) the waste to a vacuum drum filter (8) to produce a low specific volume cake easily handled on mechanical conveyors (9) for transport to hopper cars or dump trucks. A complete plant includes storage (10) metering (11) and slaking facilities (12) for lime as well as solids unloading equipment (13), (14).

Ammonia neutralization—Several processes of neutralization involving the use of ammonia in various forms have been proposed, with the basic objective of producing ammonium sulphate as a profitable by-product. The processes suffer from two major defects: complex processing steps result in an expensive plant, and there is some reluctance on the part of steel-plant management to bind a pickling operating closely to coke-oven operations (the usual source of ammonia). It is not economical to purchase ammonia for this reaction. Although two of these processes have been carried through the pilot-plant stage, it does not appear that neutralization with ammonia can be a profitable means of disposing of pickle liquor on a commercial scale.

Contract hauling—Though not destructive from a technical sense, dilution is a method of disposal which, while once quite acceptable, is no longer looked on with favor by water-conservation agencies. About the only place where it may be employed successfully is where cheap access to the open sea is available and barges may be hired to dispose of large volumes of waste. On the other hand, hauling and neutralizing are effectively combined in several localities where the spent acid is removed by contract in specially-designed trucks. Insofar as the steel pickler is concerned there is no process involved. He merely signs a long-term contract with a trucker to faithfully remove from the premises a given volume of liquor daily or weekly and theoretically, has no further concern in the matter except to approve the invoices. The contractor, on the other hand, must have some private method of destroying the acid value of the liquor. The steel producer is to be cautioned that, before signing any contract, not only should the customary investigation of the guarantees of the vendor be made, but his site and method of disposal should be checked with state water-pollution authorities to assure the practice can be continued. This contract arrangement has been found particularly attractive to the smaller steel processors for whom the capital and operating costs of neutralization facilities might prove a heavy burden. The principal drawback here is the relatively small number of operators who have equipment or an operable process to permit disposal. It would appear that the economics of the situation can justify centralized neutralization plants in most industrial centers.

REGENERATION METHODS

It is in the field of regeneration and recovery of constituents or by-products that most of the process confusion exists. As a general statement, it may be said that the vast majority of designers and inventors have lost sight of, or ignored, the low value of the commodities which they are trying to recover and have, therefore, suggested processes technically quite practical, but economically out of the question. Hodge[2, 3] a number of years ago discussed many of the mechanical and chemical methods for recovering certain values from spent pickle liquor. Even at that time, it was possible to discount practically all chemical-conversion techniques. The authors have concluded that, as of the moment, there is no commercially adaptable process which can recover the iron and sulphate values in spent liquor in any form other than iron oxide, sulphuric acid or ferrous sulphate hydrates.

It is evident, therefore, that regeneration of spent solutions to permit reuse of the unreacted sulphuric acid presents a practical avenue of attack on the disposal problem. Because of the inverse solubility of ferrous sulphate in sulphuric acid solutions, it has long been recognized that salt could be removed from spent

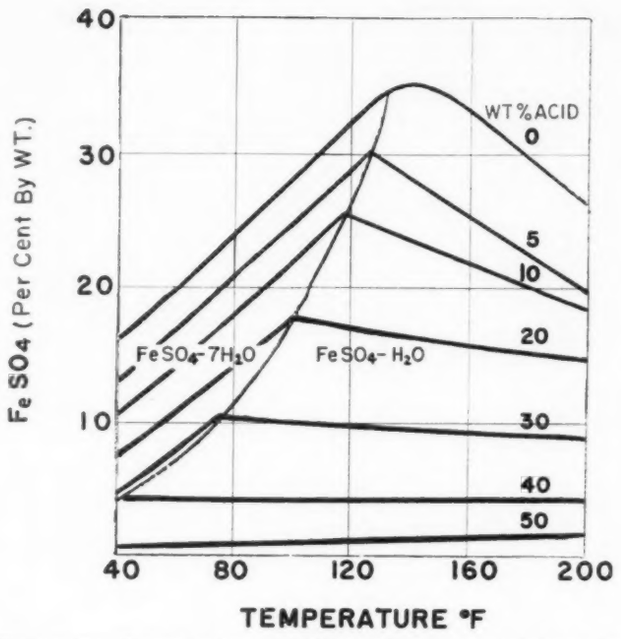


Figure 2 — Curves give solubility of ferrous sulphate in sulphuric acid solutions.

solutions by increasing the concentration of the acid until there was no appreciable quantity of iron left in the mother liquor. If the concentration process is carried out above 140 F, the salt crystals appear with only one molecule of water attached; below that temperature, seven molecules of water are removed with each molecule of sulphate. In the case of the monohydrate, temperature has a relatively small effect on solubility of the salt, particularly on lower iron concentrations. On the other hand, the removal of heptahydrate by cooling is quite feasible as can be seen by the solubility diagram (Figure 2).

Ferrous Sulphate Heptahydrate Process—Originally, the heptahydrate regeneration process was carried out batchwise in brick-lined tanks. Make-up sulphuric acid was added to the spent liquor to effect a certain degree of concentration. The solution was allowed to cool naturally, and the ferrous sulphate crystals settled to the bottom of the tank. Supernatant liquid was then returned to the pickling tanks; the crystals were removed by hand and disposed of in any convenient manner. With such a vast increase in the need for pickling capacity, this originally simple process has had to be refined and mechanized to the point where the continuous removal of salt from large volumes of liquid can be successfully accomplished.

One such plant is shown in Figure 3. Spent liquor from the pickling lines is held temporarily in a feed tank (1) and pumped (2) continuously into one end of a horizontal rotating drum (3) which is fitted with baffles to provide thorough mixing with a countercurrent blast of atmospheric air introduced at the opposite end by a blower (4). The warmed air passes through an entrainment separation drum (5) and stack (6) to atmosphere. The combination of cooling and evaporation causes ferrous sulphate heptahydrate crystals to form in the solution. The acid-crystal slurry flows by gravity to an automatic centrifuge (7) which dries the crystals sufficiently to permit conveying (8) to storage bins (9) or hopper cars. The mother liquor containing all the free acid but with a substantial reduction in iron content is dropped to a steam-coil-heated blending tank (10) where the correct quantity of make-up acid is added from a metering tank (11) prior to recycling to the pickling tanks.

The heptahydrate processes all suffer from the common disadvantage of permitting the revivified acid to have a high iron-content, and the process has therefore been commercially applicable only to batch picklers. High-speed continuous picklers require a process resulting in low-iron acid.

Ferrous Sulfate Monohydrate Process—The problem of obtaining suitable regenerated pickling solutions has been studied and investigated from many different angles and using various techniques,[4, 5] but the net result has been the same in all major respects. The solution must be concentrated either by the evaporation of water, by the addition of fresh acid, or a combination of the two, and the salt is generally removed as ferrous sulphate monohydrate.

A schematic flow diagram of the Koppers monohy-

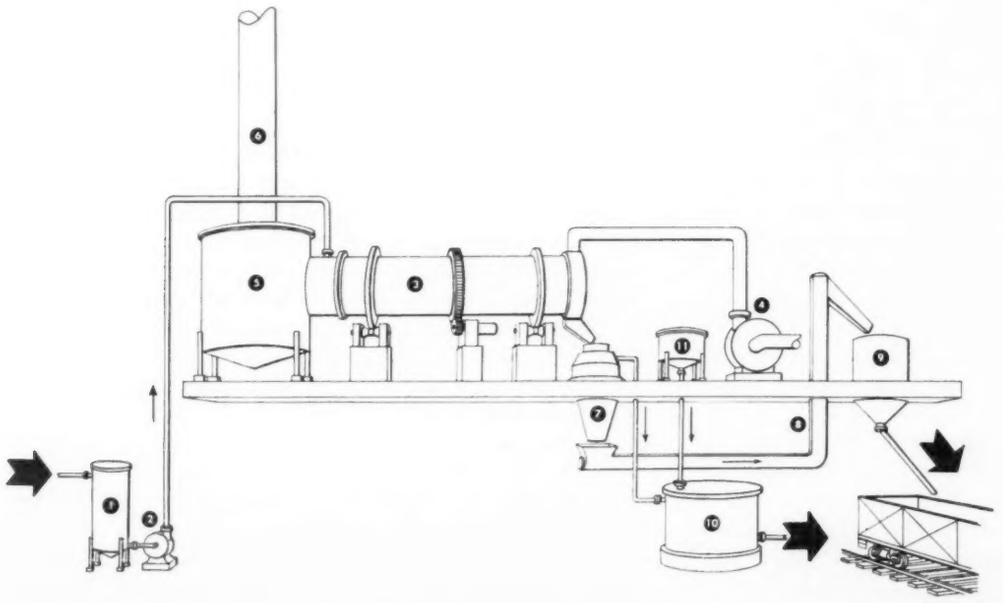


Figure 3 — Schematic diagram illustrates regeneration of steel pickling solutions by the removal of ferrous sulphate heptahydrate.

drate regeneration process[6] is shown in Figure 5. Spent acid direct from the baths or holding tanks (1) is pumped (2) to an atomizing spray-head in the large evaporation chamber (3) where it meets a blast of hot air and flue gas. This may be provided by a simple gas or oil combustion chamber (4), or by adjacent sources of flue gas blended with the correct quantity of excess air. The heated mixture effects an evaporation of water from the hot liquor, thereby concentrating the free acid. The vapor-laden air is discharged to the atmosphere through a mist eliminator (5) and stack (6).

Again, because of the solubility characteristics of the ferrous sulphate-sulphuric acid system, the weight of salt held in solution decreases as the acid concentration increases. The high temperatures involved assure the production of monohydrate rather than the heptahydrate resulting from the previously described operation. This initial concentrating process causes about 40 per cent of the ferrous sulphate to crystallize out of solution. The slurry is dropped into a crystallizing tank (7) where a volume of 66 degrees Bé sulphuric acid from a metering tank (8) is added. The make-up required is no more than that actually consumed in the pickling reaction plus all rinse losses normally involved in the steel-finishing process. The acid concentration is thereby raised a second time, dropping out more ferrous sulphate monohydrate. By these two techniques, salt concentration is so reduced that on ultimate dilution to correct pickling strength, the regenerated liquor will contain no more than one to two per cent iron.

The slurry is separated in a vacuum filter (9) or centrifuge and washed to remove residual acid. Dried salt is conveyed (10) to bins (11) or hopper cars (12) for sale or disposal. Mother liquor which contains about 35 per cent sulphuric acid is pumped to a holding tank (13) from which it may be metered directly back to the baths along with the calculated quantity of dilution water from the rinse tank. No reheating of the solution is required since the temperature is brought back to 200 F by the heat of dilution of the fresh acid. The iron content of the regenerated acid is about one to two per cent sufficiently low to be insignificant for pickling purposes.

A plant utilizing this process has been in successful commercial operation (48,000-gpd capacity) in Germany for over three years (Figure 4).

Ferrous sulphate can be disposed of in a number of ways. Small quantities can be sold on the copper as market for water or sewage treatment, or to pigment manufacturers. Because of the limited market, however, some large producers are currently dumping the material with negligible pollution of adjacent water courses. (Natural precipitation in the Pittsburgh area will wash away less than 4 per cent per year of a ferrous sulphate pile 40 ft deep.) The material may be sintered for recovery of the iron value, and some acid manufacturers have indicated a willingness to roast large quantities of ferrous sulphate monohydrate along with their normal raw material, pyrites. Finally, larger producers of the monohydrate can install their own facilities to roast the material for both iron oxide and acid recovery.

A final major advantage of the regenerative processes is worthy of mention: regeneration of the spent acid permits operation of the pickle lines at the highest

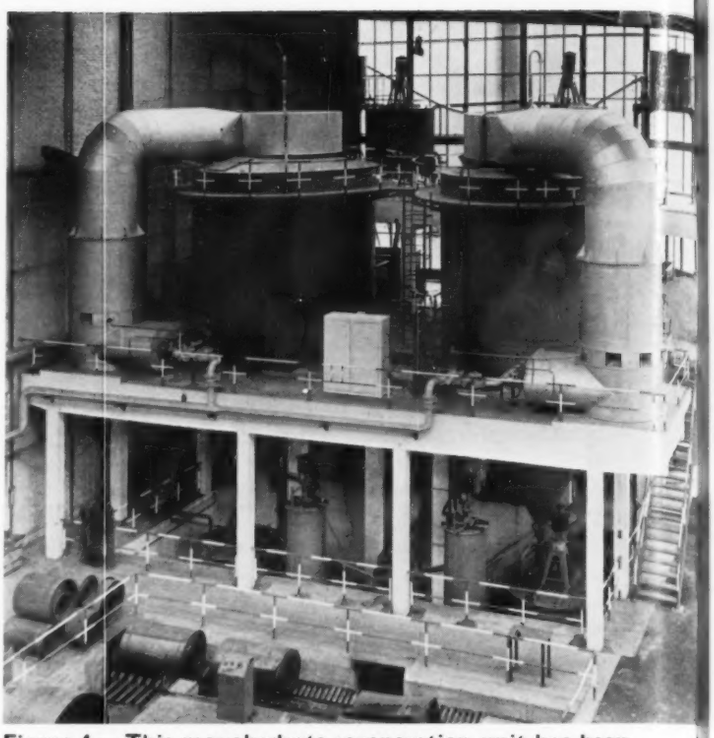


Figure 4 — This monohydrate regeneration unit has been in operation for some time at Neuwied, Germany.

desired acid strength, and very often strip speeds can be increased materially. The uniformity of acid strength similarly improves the quality of pickled product.

Ruthner Process—Another regenerative process, involving the use of hydrochloric acid as a reagent to effect conversion of ferrous sulphate to iron oxide and sulphuric acid, has been undergoing pilot plant tests at Niles, Ohio, for the last year. No public announcement has been made concerning the tests, and it remains to be seen whether the corrosion and reagent-recovery problems can be overcome and whether a commercial-size plant can be economically attractive.

PROCESS AND PICKLING CONSIDERATIONS

Having discussed types of pickling and methods of pickle-liquor treatment, it is now appropriate to investigate which treatment is most applicable to a specific pickling situation. As has been mentioned, contract hauling can only be carried out where a legally-operating trucker is available. Pricewise, this method of disposal is quite competitive with a large neutralization plant, usually above 2¢ per gal. No capital expenditure is required other than for a central collection system, which is common to any method of treatment. Neither the volume nor acid concentration of the liquor has a substantial effect on the cost of disposal, and the method is applicable with any type of acid used in pickling. The method should certainly be the first alternate evaluated and, if available, will set a maximum potential cost of disposal.

Neutralization can also be applied to any type or volume of pickling waste. Unlike contract hauling, however, the volume of liquor has a direct bearing on the cost of disposal. A certain minimum investment is required regardless of how small a volume of liquor is to be treated. If contract hauling to a suitable location

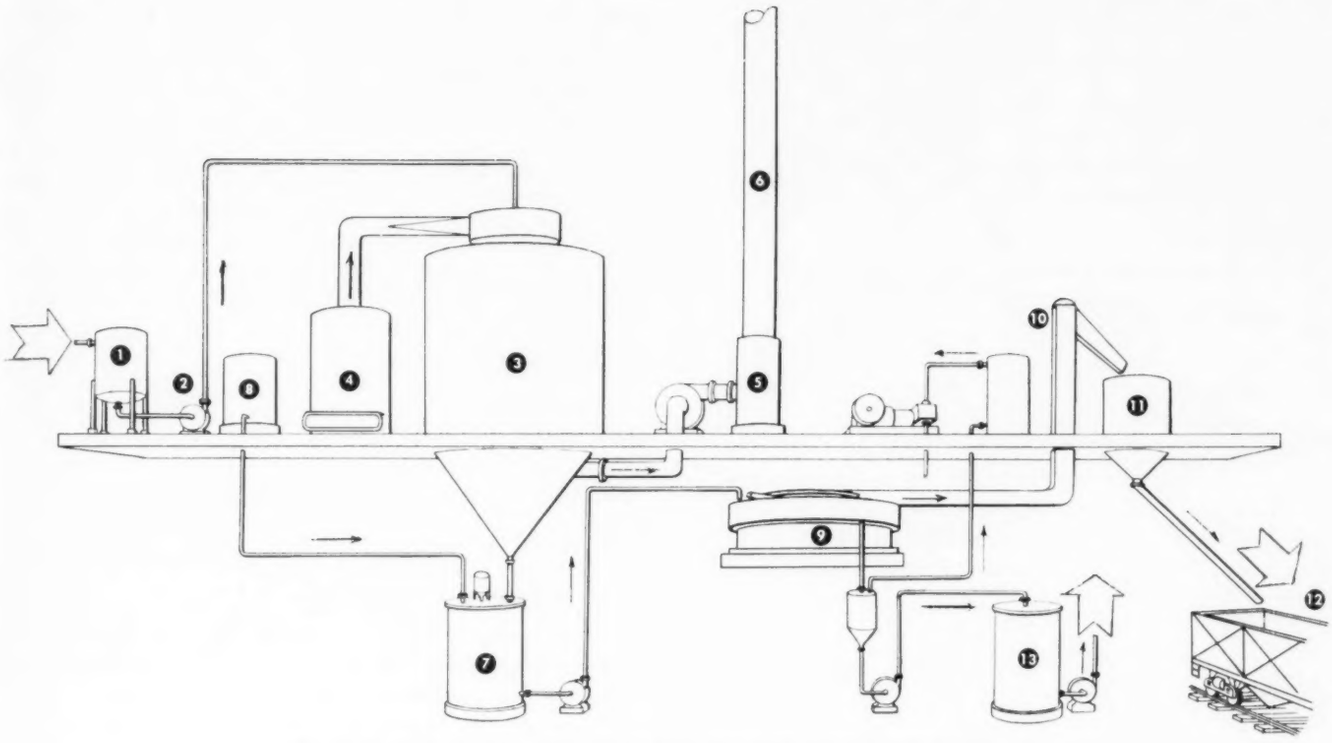


Figure 5 — Schematic diagram of monohydrate regeneration process.

is not available, certain situations will make the use of neutralization practically mandatory, as for instance the case where acids other than sulphuric are used for pickling. This includes all stainless steel, silicon steel and nonferrous pickling processes. In a few isolated cases it may be found advantageous to combine regeneration of sulphuric solutions with neutralization of other waste liquors. In any situation where free or extremely cheap basic materials are available, neutralization should be given strong consideration.[7] Limestone deposits, acetylene-sludge waste and other basic effluents from cleaning operations may all be considered as excellent sources of low-cost neutralizing materials. Except in unusual circumstances, neutralization will be the most economical answer to pickle-liquor disposal where the volume of waste involved is less than 3000 gal per day and cartage is unavailable.

The heptahydrate process is particularly adaptable to the treating of relatively small or intermittent flows of waste pickle-liquor, but it is limited by the ambient temperature conditions which fix the ultimate iron content of the regenerated pickle-liquor. Since atmospheric air is used for cooling, the plant must be designed on the basis of the average, maximum, summer wet-bulb temperature. If there is any substantial portion of the year at which this wet-bulb temperature exceeds 72 F, the process will probably not prove practical. Heptahydrate regeneration is best suited for batch pickling-plants where the normal iron-content of the pickling baths can be and normally is maintained at a higher percentage than in high-speed continuous baths. During normal operation at an average winter temperature of about 40 F, the iron in the regenerated liquor is reduced to about two to three per cent. During the summer, at an average temperature of 70 F, crystallization is not so complete and the iron content in the regenerated, refortified liquor returned to the baths may be as high as five per cent with an acid concentration of 18 per cent. This is, of course, well away from the saturation point of ferrous sulphate in sulphuric acid solution and will not be appreciably different from conditions presently encountered in batch-pickling operations.

The regeneration of spent liquor by the removal of ferrous sulphate monohydrate is ideally suited for larger continuous-pickling operations. Only under unusual conditions will it be found economical to provide this method of treatment for volumes of liquor below 30,000 gal per day. There is literally no upward limit to the volume of liquor which can be processed in parallel-multiple units. Its application in conjunction with continuous pickling is emphasized because these liquors have a higher free-acid concentration than those normally resulting from batch pickling, and it is the recovery of this free acid which makes the relatively high investment attractive. Monohydrate regeneration has not been applied to other than sulphuric-acid pickling.

In summation, steel producers using acids other than sulphuric acid can automatically disregard all regenerative techniques, and consider only neutralization and contract hauling. Sulphuric liquors from batch pickling which contain very little free sulphuric acid are not worth regenerating. A simple calculation will indicate the value of the acid now lost each year, and unless this figure is on the order of $15,000, there can be no justification for any substantial capital investment. In this case again, only neutralization and contract hauling should be considered. Any volume of liquor less than 1000 gal per week should be disposed of by dilution in an appropriate body of water. Steel producers operating continuous-pickling lines should give careful consideration to monohydrate regeneration if, as is ordinarily the case, the volume of spent liquor exceeds 30,000 gal per day. Continuous stainless pickling lines will have to resort to neutralization or a combination of neutralization and regeneration.

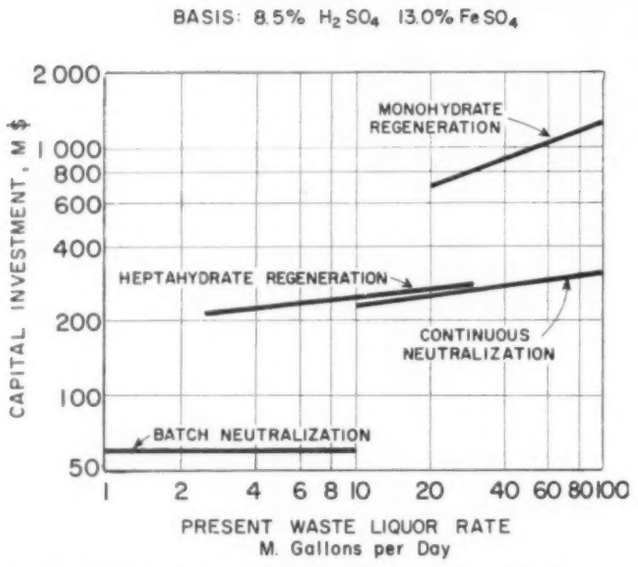


Figure 6 — Chart gives capital costs for various waste treatment plants.

INVESTMENT COSTS

The foregoing discussion has presented various physical reasons for selecting or eliminating a given method of treatment. The economics of various treatments will be the final and decisive factor on which a selection of a process will depend.

Physical limitations may well prescribe one and only one method of disposal. If, as is more often the case, two or three processes are applicable, then the final choice is made on the basis of operating and capital costs.

The investment for various plants discharging the indicated quantity of spent acid is shown in Figure 6. These graphs are based on estimates of detailed engineering specifications and cover a turnkey plant erected in place and ready for operation. In no case do they include off-battery work, such as roads, walkways, fences, service facilities, long-term storage of feed or product liquids, nor do they provide for producing any of the utilities required in the process—all of which are assumed to be provided by the buyer at the plant site. The cost does cover the procurement, engineering and erection of all the foundations, buildings, piping, equipment and instruments required to conduct the process. For example, the neutralization plants include storage for a minimum of one week's supply of lime, as well as the actual process equipment. For batch processing, the lime is bagged and no facilities are provided for dewatering the sludge. In the continuous-neutralization plants, bulk lime-storage and filters are provided to reduce the volume of neutral sludge. In the case of heptahydrate plants, it has been found advantageous to install the equipment on an elevated platform either inside or outside existing buildings, thereby avoiding uneconomical use of production areas. The investment includes the cost of this structure. The cost of the monohydrate plants includes the building to house the filter, pumps and other mechanical equipment required in the process. It does not include a spent-acid-collection system to gather together several sources of liquor, nor does it provide more than 4 to 5 hr hold-up of the regenerated liquor.

A 10,000-gpd, batch-neutralization plant will cost about $60,000, and since this is almost a minimum-sized plant, this represents about the least cost for even the smallest operation. Heptahydrate regeneration and continuous neutralization plant costs lie on essentially the same curve, ranging from $210,000 at 3000 gpd to $320,000 at 100,000 gpd. Finally, the monohydrate regeneration plant costs between $750,000 at 25,000 gpd and $1,300,000 at 100,000 gpd.

It should be emphasized that, while these prices cover complete turnkey process units, local site conditions can materially affect total plant cost. For instance, one steel-plant operator recently estimated that he would have to spend $150,000 merely on sewers to collect his waste-acid streams at a central clearing site for treatment by any technique. On the other hand, substantial investment for steam generation or power supply will not be required since utility requirements, except for fuel oil or gas, are only nominal.

OPERATING COSTS

The chemical, utility and labor requirements for four processes are summarized in Table I. Unit quantities of by-product, as well as utilities and chemicals, are given for handling 1000 gal of waste liquor. The large amount of sludge to be handled in the neutralization plants is readily evident.

Total daily operating-costs for the neutralization and regeneration processes are tabulated in Table II. The first column considers a minimum-size neutralization plant processing a 5000-gal batch of waste liquor once a week. The next column considers the same plant operating at about two-thirds of maximum capacity, processing two 5000-gal batches per day, seven days per week. Continuous neutralization plants are evaluated in columns 3 and 4.

Lime is presumed available at the current market price of $18.50 per ton, and operating labor is charged at $2.75 per man-hour. A charge of $1.50 per ton is included for hauling away the slurry from each plant, and appropriate maintenance, overhead and depreciation charges (15-year) have been included. The last line of the table shows the net processing cost per gallon of waste liquor treated. It is interesting to note that the

TABLE I

Chemical, Utility and Labor Requirements Per 1000 Gal Waste Pickle-Liquor (8.5 Per cent H_2SO_4, 13.0 Per cent $FeSO_4$)

	Neutralization		Regeneration	
	Batch	Continuous	Hepta-hydrate	Mono-hydrate
Capacity range, mgpd				
Minimum	0	5	2	20
Maximum	10	100	50	150 plus
Plant by-product	20 per cent slurry	50 per cent sludge	$FeSO_4 \cdot 7H_2O$	$FeSO_4 \cdot H_2O$
Tons per 1000 gal	7.6	3.1	1.2	0.7
Chemicals				
Lime, ton	0.5	0.5	...	...
Utilities				
Steam, 1000 lb	...	...	1.3	...
Water, 1000 gal	Neg	Neg	Neg	2.6
Fuel, 1,000,000 Btu	...	...	...	5.4
Electricity, kwhr	37	28	106	64.2
Operating labor				
Men per shift	1	1	½	2

TABLE II
Daily Processing Cost for Various Pickle-Liquor Treatment Plants

	Neutralization				Heptahydrate		Monohydrate		
Type of operation	Batch	Batch	Cont.	Cont.	Cont.	Cont.	Cont.	Cont.	Cont.
Capacity, gal per day	714	10,000	20,000	100,000	2,520	5,890	29,700	51,900	82,400
Investment, $	60,000	60,000	269,000	332,000	210,000	232,000	825,000	975,000	1,200,000
Chemicals (lime), $ per day[a]	7	99	198	990	...	...	...	...	...
Utilities, $ per day									
Steam[b]	...	...	...	...	2	4	...	...	...
Service water[c]	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	1	1	2
Electricity[d]	Neg.	3	5	22	2	5	15	26	42
Fuel[e]	...	...	...	...	...	...	65	115	178
Operating costs, $ per day									
Supervision	...	...	...	...	...	...	18	18	18
Operating labor[f]	3	66	66	66	35	35	131	131	131
Maintenance labor[g]	4	4	19	24	15	17	62	73	90
Maintenance material[h]	4	4	19	24	15	17	62	73	90
Shipping residue[i]	8	114	92	461	3	7	21	37	59
Operating and laboratory supplies[j]	...	...	...	...	...	...	14	18	23
Fixed costs, $ per day									
Plant overhead[k]	4	35	44	46	25	26	107	121	140
Property taxes and insurance[l]	3	3	15	19	12	13	50	59	72
Depreciation[m]	11	11	50	64	40	45	165	195	240
Gross processing cost, $ per day	44	339	508	1716	149	169	711	867	1085
Credit for sulphuric acid, $ per day[n]	...	...	...	...	24	58	299	524	832
Net processing cost, $ per day	44	339	508	1716	125	111	412	343	253
Net processing cost, ¢ per gal	6.2	3.4	2.6	1.7	5.0	1.9	1.4	0.66	0.31

Footnotes:
[a] High calcium lime $18.50 per ton.
[b] $0.60 per 1000 lb.
[c] $0.01 per 1000 gal.
[d] $0.008 per kwhr.
[e] $0.40 per 1,000,000 Btu.
[f] $2.75 per man-hour.
[g] 2.5 per cent of investment.
[h] 2.5 per cent of investment.
[i] $1 per ton of salt and $1.50 per ton of lime sludge.
[j] 0.6 per cent of investment.
[k] 50 per cent of all labor.
[l] 2 per cent of investment.
[m] 15-year write-off.
[n] $24 per ton of 100 per cent acid.

much larger investment in the continuous plant, largely attributable to dewatering facilities, is more than justified at the higher rates by the reduction in the volume of sludge to be carted away.

Similar analyses are provided for the heptahydrate and monohydrate regeneration plants. All of the cases are based on the assumption of treating waste liquor analyzing 8.5 per cent sulphuric acid and 13.0 per cent ferrous sulphate, and regenerated acid is credited at the current market price of $24 per ton of contained H_2SO_4. Credits would naturally be materially different if the waste material has a widely different acid content.

The heptahydrate process presumes installation near the pickle lines so that the minimal operation attention can be provided by the pickle-line attendants. Both regenerative processes are charged $1 per ton for disposal of the ferrous sulphate. No credit has been included for converting ferrous sulphate monohydrate into iron oxide and sulphuric acid. This operation is sufficiently attractive to permit rapid depreciation and good return on the additional investment required. Generally, this operation is of interest to the sulphuric-acid manufacturer rather than the pickle-line operator.

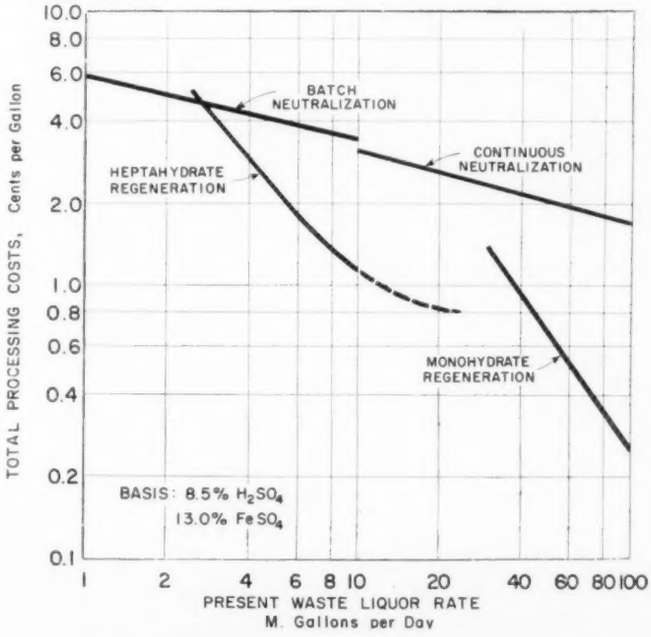
The net unit processing costs for the several processes are plotted as a function of plant throughput (Figure 7). Although not shown on this graph, it should be kept in mind that, when available, contract hauling of waste usually costs between two and four cents per gallon.

These curves show rather conclusively that neutralization with lime at $18.50 per ton cannot cost much less than 2¢ per gal of waste liquor and can in fact go as high as 4 to 6¢ per gal for small quantities. Certainly contract hauling, which permits the small operator to receive the benefits of consolidating wastes from several plants into one large operation, is to be preferred unless sludge-disposal costs are appreciably less than the assumed $1.50 per ton.

In those batch-pickling installations where the heptahydrate process can be considered, the higher capital costs can be justified by the acid savings from above about 5000 gpd of waste solution. In fact, it will appear that this process is about the only hope of reducing processing costs below about 2¢ per gal in plants of less than 30 to 40,000-gpd capacity.

Finally, the monohydrate regeneration process shows costs dropping from 1¢ per gal at about 40,000 gpd to

Figure 7 — Chart gives total processing costs for waste-acid treatment.



less than ¼¢ per gal at 100,000 gpd. The writers know of no process commercially available today which can show a more attractive disposal cost. Although the process is interesting only above 30,000 gpd throughput and requires a substantial investment, the large potential savings in acid credit permits large reduction of the net operation cost.

It should be noted that in the larger plants unit costs of a few cents per gallon can mean rather enormous annual costs. For instance, if an operator incurs a cost of 2¢ per gal to neutralize 100,000 gpd of waste liquor, his annual disposal costs amount to $700,000 per 350-day year. If this operator installs a monohydrate regeneration plant, his net operating cost of ¼¢ per gal will permit savings of $625,000 per year and pay out the $1,300,000 investment in two years! A disposal plant which can show 50 per cent return on the investment is certainly worthy of serious and immediate attention.

We conclude that monohydrate regeneration plants present a very attractive investment above 30 to 40,000 gpd. Above this rate, an operator cannot afford to continue neutralization.

SUMMARY

Four techniques of disposing of or processing spent-pickling wastes are currently commercially practical. Contract haul-away service is available in many industrial areas at costs usually in excess of 2¢ per gal of waste liquor and offers a no-investment means of eliminating pollution. For other areas, a minimum investment of about $60,000 is required for a batch-neutralization plant adequate for handling up to 10,000 gpd of waste liquor at gross operating costs (including amortization and cost of disposal of the sludge) in the order of 3½ to 6¢ per gal. Continuous neutralization requires higher investment, in the order of $250,000 including sludge filters, but permits reduction of the disposal cost to about 2¢ per gal at rates above 50,000 gpd.

The heptahydrate process of waste-acid regeneration permits operation of medium-size batch-pickling plants to process 6000 to 12,000 gpd or more of waste acid for between 2¢ and 1¢ per gal of waste liquor and requires an investment in the order of $250,000. The monohydrate process of regeneration requires an investment ranging from $700,000 for 20,000 gpd capacity to $1,300,000 for 100,000 gpd, but is able to show net operating costs after 15-year depreciation ranging from 1½¢ to ¼¢ per gal at the higher throughput.

All of these processes are in commercial operation today and offer simple, practical and fool-proof solutions to waste pickle-liquor disposal problems.

BIBLIOGRAPHY

1. "The Making, Shaping and Treating of Steel", 6th Edition 1951, U. S. Steel Corp., Pittsburgh, Pa.
2. "Waste Problems of the Iron and Steel Industries," by Willard W. Hodge, Industrial and Engineering Chemistry, Vol. 31, November, 1939.
3. "Steel Mill and Coke By-Product Wastes," by Willard W. Hodge, 15th Annual Water Conference, Engineers Society of Western Pennsylvania, October 18, 1954.
4. "Hanbuch der Metallbeizerei," by Otto Vogel, Vol. 2, 1951.
5. "Disposal of Spent Sulphate Pickling Solutions," compiled by R. D. Hoak for the Steel Industry Action Committee of the Ohio River Valley Water Sanitation Commission, October, 1952 (38 references).
6. "Regeneration of Waste Pickle Liquor to Produce Ferrous Sulphate Monohydrate," by J. S. Atwood, J. S. Joseph, and W. W. Hodge, 12th Purdue Industrial Waste Conference, Lafayette, Ind., May 13-15, 1957.
7. "Basicity Factors of Limestone and Lime-Evaluation as Neutralizing Agents," by R. D. Hoak, C. J. Lewis, and Willard W. Hodge, Industrial and Engineering Chemistry, Vol. 36, March, 1944.

Discussion

PRESENTED BY

DR. R. D. HOAK, Senior Fellow, Mellon Institute of Industrial Research, Pittsburgh, Pa.

JAMES S. JOSEPH, Sales Engineer, Koppers Co. Inc., Engineering and Construction Div., Chemical Dept., Pittsburgh, Pa.

LEONARD LARSON, Chief Engineer, Cleveland Works, Republic Steel Corp., Cleveland, Ohio

STEPHEN VAJDA, Special Engineer, Office of Chief Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

Dr. R. D. Hoak: The authors have presented an instructive discussion of the unpleasant job of disposing of pickle liquor. They correctly point out that the low value of the constituents of pickle liquor militates against attempting to recover any values from it, and they also conclude correctly that the producer of relatively small volumes is unlikely to find any better alternative than neutralization.

One method of destructive disposal that was not mentioned is discharging the spent liquor on hot furnace slag. This method has been used in one plant for several years with complete success. I realize that that method of disposal is not always possible.

Mr. Joseph described an embodiment of a continuous process for neutralizing pickle liquor which, as a secondary step, uses vacuum filtration to reduce the volume of slurry that has to be handled. He did not suggest that anything other than adequate mixing of lime with the pickle liquor would be required to provide a filterable slurry.

As you may know, the lime slurry which is produced in the neutralization operation does not filter very well. A process is available in commercial operation which simplifies the filtration operation considerably. The process involves partial oxidation of the final slurry, and this permits filtration at a rate some 20 times that which is achieved when aeration is not practiced. The filter cake contains about 60 per cent dry solids. I have seen such an operation, and it works very well indeed.

There is a further advantage in the so-called aeration neutralization process which lies in the ability to utilize the basicity advantage of dolomitic lime. When dolomitic lime is used to neutralize pickle liquor, it produces a much bulkier slurry than when high-calcium lime is used. This would not ordinarily be expected, because magnesium sulphate, one of the products of the reaction, is quite soluble. It is the case, however, the slurry produced with dolomitic lime is quite fluffy and settles very poorly. With the aeration-neutralization technique, this disadvantage is overcome, and the higher basicity can be taken advantage of. Dolomitic and high-calcium limes sell at about the same price per ton, but

dolomitic lime has about 18 per cent more basicity per ton than high-calcium.

The authors have dismissed the use of ammonia in one form or another to treat pickle liquor, and I must agree that when ammonia is purchased to treat pickle liquor, the process is economically unattractive.

When the process for treating pickle liquor directly with ammonia was first developed, ammonium sulphate production was a profitable operation. This was during the last stages of World War II, when all the ammonium sulphate that was produced could be sold at a profit.

Looking ahead, it was concluded that the opportunity to sell ammonium sulphate at a profit was a transitory one which would change in a relatively few years. As a result of that conclusion, work was directed toward the development of a process which could be used to treat pickle liquor directly with raw coke oven gas, and such a process has been evolved through the pilot plant stage.

It is important to bear in mind that the process was not planned to produce more ammonium sulphate. It was designed to use sulphuric acid twice, once for pickling and once for making ammonium sulphate. It is essential to remove ammonia from coke oven gas and the most satisfactory way in most instances has been to convert it to ammonium sulphate. Thus this process should not be written off as one which is likely to be commercially practicable.

The process has the additional advantage of removing hydrogen sulphide from coke oven gas in an amount equivalent to the iron in the pickle liquor, and the sulphur equivalent can be recovered as elemental sulphur with a purity of 94 to 95 per cent. This material can be used for fertilizer use or for acid manufacture.

The section of the paper dealing with production of monohydrate states that the iron content of the regenerated acid is about one to two per cent, which is sufficiently low to be insignificant for pickling purposes. I question the insignificance of one to two per cent iron. A continuous strip pickler usually discharges spent liquor at a concentration of five per cent iron or less.

The authors say that when a plant has less than about 1000 gal of pickle liquor a week, it should be disposed of by dilution in an appropriate body of water. I do not believe that the Pennsylvania Department of Health would go along with that suggestion, because a number of years ago there was a conference between all of the steel companies in Pennsylvania and representatives of the Department of Health, wherein it was agreed by the companies that all strong liquor would be neutralized. Following that conference the Department of Health established a limit for the amount of acid which might be discharged with the rinse water at 25 per cent of the acid purchased for pickling.

Last year, for Allegheny County alone, that figure was reduced to 12½ per cent of the acid intake, so that I do not believe that it is proper to suggest that the way to dispose of a relatively small quanity of liquor is to discharge it to an appropriate body of surface water.

James S. Joseph: I do not think we have any quarrel with your comments concerning the 1000 gal a week of waste liquor. If we can eliminate the major causes of pollution, small plants that are dumping 1000 gal a week can readily be taken care of.

Concerning neutralization, Dr. Hoak's comments are all quite correct. The most definitive treatise we have seen on the subject of neutralization has been published by Dr. Hoak, and I refer all of you who are contemplating neutralization to that publication.

Concerning the ammonia process, this is a ticklish matter. As you all know, our company is associated with the by-product coke industry, and we have found that many of the coke oven operators are very reluctant to tie themselves up with a pickling operation. Certainly the waste acid storage requirements would be very large.

I admit it is a very desirable way on paper of disposing of two waste products (ammonia and waste pickle liquor), and at the present time the use of commercial sulphuric acid to convert by-product ammonia to ammonium sulphate is not particularly attractive. However, it is my opinion that this problem can more readily be solved by the production and sale of straight solutions, rather than by compounding ammonia into another fertilizer.

Dr. Hoak questioned whether the iron content of the pickle liquor is sufficiently low for use in continuous pickling. Extensive test work in the United States reported by Martin (Blast Furnace and Steel Plant, *36*, 1089–94, September, 1948) and actual operating experience in the German plants now using the regenerative process have proven that the residual iron content does not adversely affect pickling rates. In fact, the process has been utilized in Germany to increase the pickling rate and capacity of existing tanks through operation with higher acid concentrations.

Leonard Larson: The authors of this paper are to be complimented on their comprehensive presentation of a subject of common interest to those of us concerned with the problem of control and disposal of waste pickle liquor, particularly those confronted with large volumes accruing from continuous pickling of steel strip, where a multiplicity of lines may be employed using from 30 to 40 lb of acid per ton of steel pickled.

We all realize that steps to provide improved control of this waste is necessary as fast as practical and economic methods are available.

Where higher volumes are involved, the authors' analysis indicates a strong preference toward application of the monohydrate process, entailing an appreciable investment, but offering the lowest cost.

Our preference would be to find a method whereby this waste could be profitably handled, but this seems to offer little or no hope. The obvious alternate is that method which involves the minimum cost. The monohydrate process as outlined by the author offers considerable interest. The costs are cited per gallon of pickle liquor. I would appreciate having the author convert his figure to cost per ton of steel processed on typical continuous pickling lines.

James S. Joseph: The production rate of waste pickle liquor per ton of steel varies greatly even in the same plant and so it is difficult to convert pickle liquor processing costs to cents per ton of steel accurately. However, in at least one plant of which we have knowledge, 100,000 gal of waste liquor results from pickling about 3300 tons of steel per day. The total regeneration cost of ¼¢ per gal, including depreciation, is therefore equivalent to about 8¢ per ton of steel. This compares quite favorably with neutralization or con-

tract hauling at 2¢ per gal or about 65¢ per ton of steel.

Stephen Vajda: This is another one of the many problems facing the steel industry brought about by civic interest in air and stream pollution. It has no direct connection with steelmaking itself, but it must be solved and the cost absorbed. Therefore, it is to everyone's advantage to do it as simply and inexpensively as possible. Incidentally, this problem like so many others in this field is rather frustrating, in that after the acid has been completely eliminated by the steel mills, one will not be able to measure its effect on the rivers in the Pittsburgh district.

As the authors point out the problem can be attacked in two ways: (1) by destroying the spent liquor or (2) by regenerating and reusing it.

To the two methods of destruction presented by the authors—neutralization on the site and after being hauled away and dilution—I would like to add a third. This would be deep well disposal.

Deep well disposal is used extensively in the oil fields and is commonly used in Michigan. The wells can vary in depth from 600 to over 3000 ft. The depth will depend on the type of strata in the vicinity and its conformation. One must guard against the waste liquors being able to rise and contaminate the surface waters. The power required to pump will depend on the structure of the strata—that is its density and hydrofacing characteristics. Pumping pressures can vary from several hundred to several thousand psi. A filtering system must be used to prevent choking the strata.

In the matter of regenerating and reusing the acid—one wonders whether the cure is not more fatal than the disease. One cannot deny the advantage of faster pickling by the use of higher acid strength, but the ferrous sulphate disposal problem seems insurmountable. To date, the disposal of heptahydrate has been worrisome—one acid manufacturer offered to take it FOB their plant. The dumping of the salts leaves the steel company with a difficult decision. This same acid manufacturer, offered to buy the monohydrate—at such a low price that one cannot afford to make it. As for roasting to make acid, one need only to quote the authors themselves, "Either raw material for pickle liquor, iron and sulphuric acid, costs only a few cents per pound, and only under most unusual circumstances can the regeneration of these raw materials be achieved at a profit."

It was because of this very fact that the Ruthner Process was chosen by several steel companies as a possible solution. This process has only two products—regenerated acid and iron oxide. Despite this incentive the high investment costs makes one pause. Present studies indicate that a payout time of 8 to 10 years is required, after taxes, when compared with contract hauling and neutralization. This neglects any credits for faster pickling.

A cost study for a 100,000-gpd plant similar to that presented by the authors, was prepared by the Steel Industry Action Committee of the Ohio River Valley Water Sanitation Commission, Subcommittee on Spent Pickling Solutions, several years ago. The same ratio existed between the investment and operating costs of the different methods, but the investment and operating costs were roughly twice that used by the authors. The contract hauling cost of $0.02 per gal remains the same.

James S. Joseph: The disposal of waste acid in deep wells may prove to be a suitable means of disposal in those instances where the difficulties Mr. Vajda pointed out can be overcome.

Concerning disposal of ferrous sulphate, we would believe that producers of sulphuric acid who now roast pyrites represent the most practical outlet for the by-product salt. Their present reluctance to pay for the material does not affect the economics we have presented here—in fact, we have charged the regeneration plant $1 per ton against the freight costs for shipment to an acid manufacturer.

Finally, the capital investment curves we have presented are based upon recent firm proposals by the authors' company to build turnkey battery limits plants, and the operating costs for the regeneration plants are based upon actual plant operating experience. ▲

There is a demand for copies of the following Yearly Proceedings:

1936 1937 1938 1939 1940

1943 1944 1947 1952

If your copies are not in use please get in touch with us.

ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

. . . . as rod delivery speed is increased, two control design criteria assume greater proportions . . . . these are the response of the drive to the operator's control and to load changes, and the accuracy at which given conditions, such as speed, are maintained . . . .

Electrical Drive System
for a high speed combination rod mill

by A. F. KENYON
Advisory Engineer
and H. J. OAKES
Consulting and Application Engineer
Industry Engineering Dept.
Westinghouse Electric Corp.
Pittsburgh, Pa.

AN over-all description of the new combination rod mill recently put into operation at the Cuyahoga Works of the American Steel & Wire Div.—United States Steel Corp., was given in a paper "American Steel and Wire's New Rod Mill" by W. V. Magee, assistant chief engineer of American Steel and Wire Div., and published in the September, 1957 issue of the *Iron and Steel Engineer*. Therefore this paper is limited to a discussion of the electrical features. The 13,500-hp total capacity of the nine main drive motors establishes a record high for this type of mill, and the electrical drive equipment incorporates many notable features.

MILL AND DRIVE ARRANGEMENT

Figure 1 shows the schematic plan arrangement of the rod mill and main drive motors, and indicates the straightaway continuous arrangement of stands No. 1 to No. 23 for rolling fine rod, and the two auxiliary looping stands No. 16a and No. 17a used when finishing coarse rod.

ELECTRICAL DRIVE ARRANGEMENT

Figure 2 is a general view of the rod mill motor room showing the "A" to "G" main drive motors along the

Figure 1 — Schematic plan arrangement shows rod mill and main drive motors.

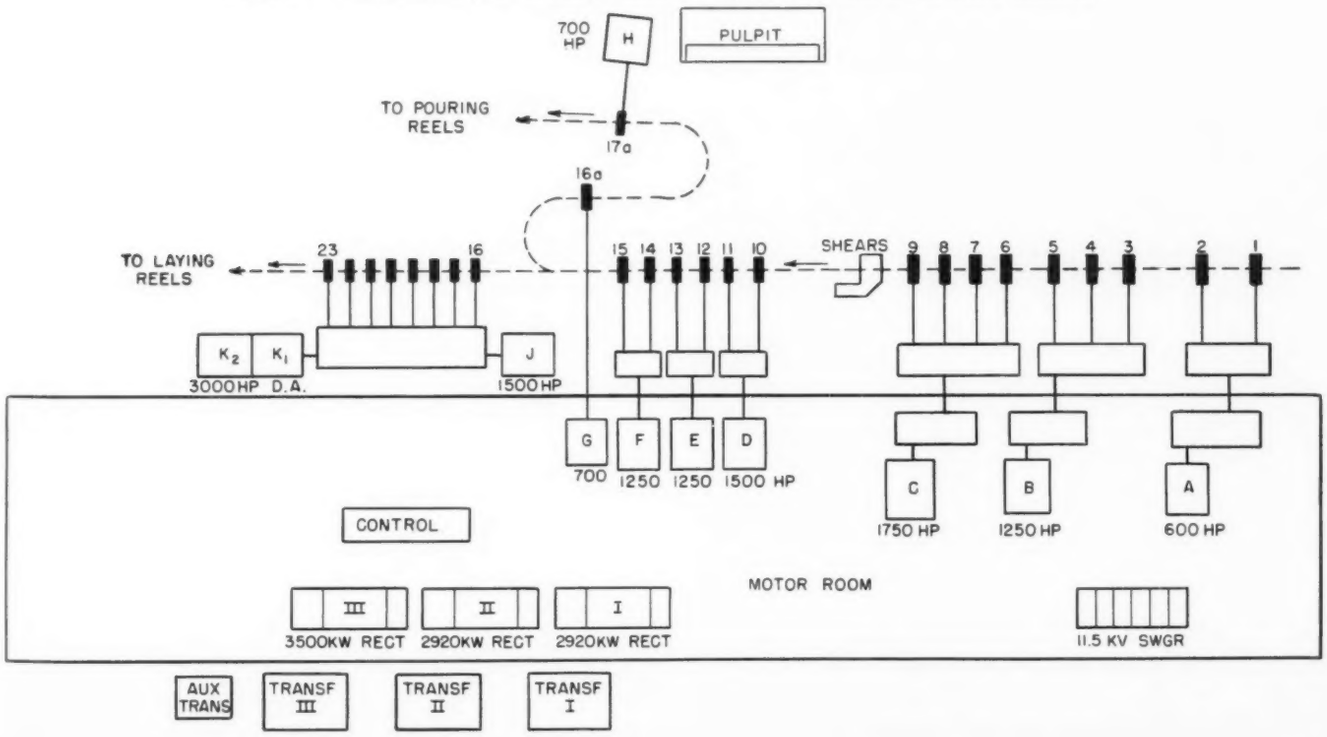


Figure 2 — General view of rod mill motor room.

left wall, the three main power supply ignitron rectifier substations along the right wall, the 11,500-volt metal-clad switchgear in the right background, and the substation meter, speed regulator and master control duplex board in the central foreground.

Table I lists the ratings of the nine main drive motors.

Stands No. 1 and No. 2 of the roughing mill are driven together by a 600-hp, 300/950-rpm motor "A," stands No. 3, 4 and 5 are driven together by a 1250-hp, 225/675-rpm motor "B," and stands No. 6, 7, 8 and 9 are driven together by a 1750-hp, 200/550 rpm motor "C."

Figure 3 is a closeup view of the three roughing mill motors, 1750-hp motor "C" being in the foreground, 1250-hp motor "B" in the middle, and 600-hp motor "A" in the background. The primary gear reducers for the three roughing mill drives are installed in the motor room, while the multiple-spindle secondary gear drives for the roughing mill, also the double spindle gear drives for the intermediate mill, are located outside the motor room.

Stands No. 1 to 9 constitute the roughing mill, and the three roughing mill motors "A," "B" and "C," totaling 3600 hp, are connected to bus section "I," and are supplied from one 2920-kw rectifier.

The six intermediate stands No. 10 to No. 15 are driven in three pairs by the 1500-hp, 225/580-rpm motor "D," and two 1250-hp, 225/620-rpm motors "E" and "F," respectively. Stands No. 10 to No. 15 constitute the intermediate mill, and the three intermediate mill motors "D," "E" and "F," totaling 4000 hp, are connected to bus section "II," and are supplied from a second 2920-kw rectifier.

In Figure 4, the three motors at the right are the two 1250-hp and one 1500-hp intermediate mill motors, "D," "E" and "F," and at the left is the 700-hp looping stand motor "G."

When operating as a looping mill, producing coarse rod, stands No. 16a and 17a are driven by two 700-hp motors "G" and "H," respectively. When operating as a continuous mill, producing small rod, the bars proceed straight ahead from the intermediate mill to the eight-stand continuous finishing mill, stands No. 16 to No. 23 inclusive. The drive for the finishing mill consists of the 1500-hp, 690/960-rpm motor "J" coupled to one end of the layshaft, and 3000-hp, double-armature motor "K" coupled to the other end of the layshaft, thus essentially providing a 4500-hp triple armature drive. The three 1500-hp units are connected in parallel, and load division between the three units is achieved by means of three rotating load balance regulators. The control includes provision to operate with any one of the 1500-hp units electrically disconnected. The three armatures also are interchangeable.

The two 700-hp, looping mill motors "G" and "H," or alternately the 4500-hp finishing mill "J-K" drive, are connected to bus section "III," and supplied from a third 3500-kw rectifier.

Figure 5 shows the 3000-hp, 690/960-rpm double-armature motor "K" coupled to one end of the finishing mill layshaft. The 1500-hp motor "J" coupled to the other end of the finishing mill layshaft, is installed inside the protective house at the far end of the gear drive. The "J-K" motors, also the looping stand motor "H" are installed in the mill building and are equipped with complete front and rear enclosing covers for forced ventilation through ducts from fans in the motor room basement. Covers over the large access openings in the front endbells are held securely by snap fasteners and may be quickly and easily removed for inspection or maintenance of the brushes and commutator.

MAIN DRIVE MOTORS

The rod mill main drive motors are designed for operation from 700-volt direct current, and are stabilized, shunt-wound, separately excited, with speed adjustable by shunt field adjustment over the rated ranges as listed in Table I. The motors are suitable for operation down to 410 volts to obtain minimum operating speeds down to 60 per cent of the rated full field base speeds.

To enable successful operation of the high-speed continuous mill rolling four strands throughout the mill and producing extremely long finished rods, it is necessary that the motor drives have very good speed regulation in order to avoid looping or pulling the bars between stands. All of the main drive motors were built in frames somewhat larger than required to develop the specified

TABLE I
Combination Rod Mill Main Drive Motors

Drive	Stands	Motor hp	Motor rpm
A	1–2	600	300/950
B	3–4–5	1250	225/675
C	6–7–8–9	1750	290/550
		3600	
D	10–11	1500	225/580
E	12–13	1250	225/620
F	14–15	1250	225/620
		4000	
G	16a	700	200/680
H	17a	700	250/790
		1400	
J–K	16–23	3 x 1500 = 4500	690/960
		Total 13,500	

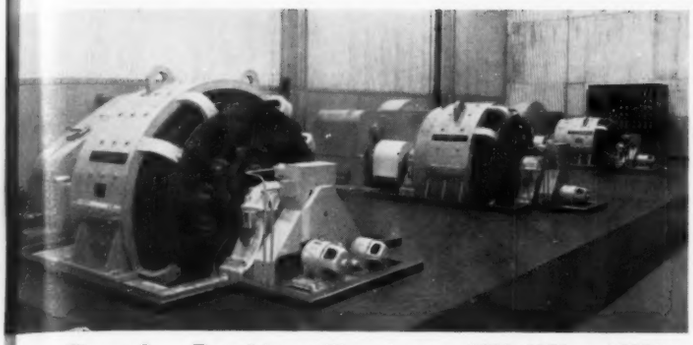


Figure 3 — Roughing mill motors are 1750, 1250 and 600 hp.

ratings, in order to obtain good inherent speed regulation and low impact speed drop characteristics. The armature circuit IR drop is thus quite low, ranging from less than $1\frac{3}{4}$ per cent of rated voltage on the high-speed "J-K" motors to about 3 per cent on the low-speed "G" and "H" motors. The motors are designed and adjusted so the inherent steady state speed regulation is approximately equal to the armature circuit IR drop. Also the control equipment includes a magnetic amplifier speed-regulating equipment, operating through a buck and boost exciter in the field circuit of each motor, by which the speed of each of the motors is matched to a common reference. The speed regulators are designed to maintain the steady state speed regulation—the difference in speed between no-load and full load expressed as a percentage of the full load speed—at not more than 0.25 per cent at any speed within the rated speed range. This steady state speed regulation performance has been more than met in the regular operation of the mill.

With each motor except "G" and "H" driving two or more stands, and the motor ratings selected on the basis of normal four-strand rolling, the incremental load change on any motor when one bar enters or leaves a stand is relatively small, so that the impact speed drop characteristics of the motors are not of critical importance. However some coarse rod sections may be rolled single strand and finished from the intermediate or looping mill with somewhat larger incremental load changes, and under any conditions it is desirable that the impact speed drops be kept at the minimum practicable values. The oversize of the motors tends to increase the mechanical inertias and to reduce the armature circuit resistances and inductances. The motor designs were made to obtain proportions of armature WK^2 and armature and field circuit resistances and inductances which will result in the minimum practicable impact speed drops without resorting to external flywheels or excessive oversize of the machines.

When operating at full field base speed the regulated impact speed drops are not appreciably lower than the inherent impact speed drops of the motors without any regulating equipment, because the mechanical time constants are so short that the regulators cannot respond. However when operating at weakened field speeds, the time constants are such that the regulators can respond and the regulated impact speed drops are less than half of the inherent impact speed drops of the motors without regulators. The motor speed regulators thus are quite effective in improving the transient impact speed drop characteristics of the drive motors as well as providing the best possible steady state speed regulation.

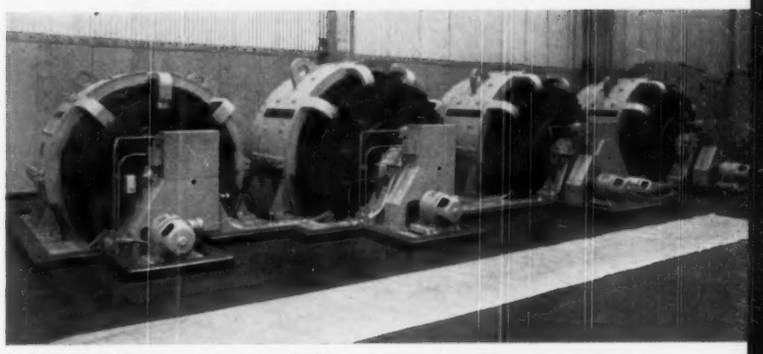


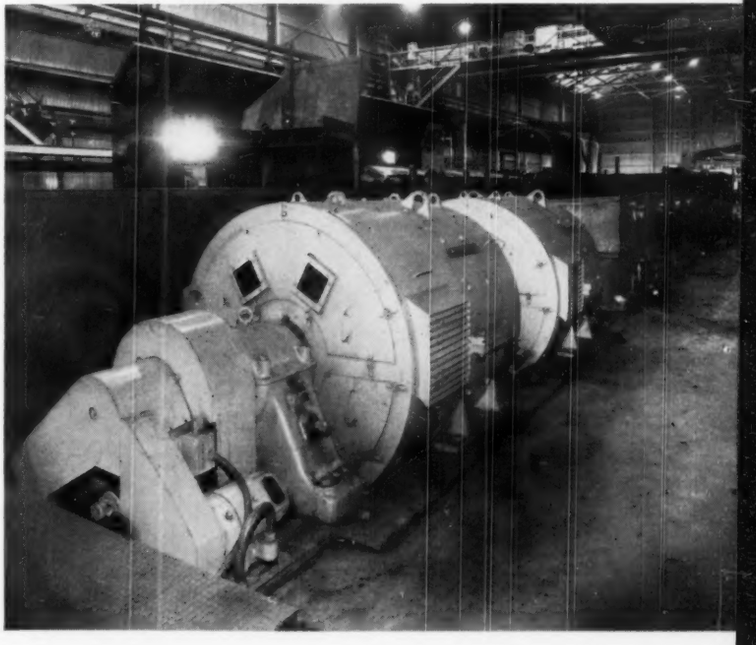
Figure 4 — Shown here are 700-hp looping mill motor "G," intermediate mill 1250-hp motor "F," 1250-hp motor "E," and 1500-hp motor "D."

MAIN POWER SUPPLY RECTIFIERS

Figure 6 is a schematic diagram of connections for the rod mill drive motors and the three power supply rectifiers. The three roughing mill motors "A," "B" and "C," totaling 3600 hp, are connected to bus section "I" and supplied from a 2920-kw, 700-volt, ignitron rectifier. The three intermediate mill motors "D," "E" and "F," totaling 4000 hp, are connected to bus section "II" and supplied from the second 2920-kw, 700-volt rectifier. The two 700-hp looping mill motors "G" and "H," or alternately the finishing mill 4500-hp (3 x 1500-hp) drive "J-K," are connected to bus section "III" and supplied from the 3500-kw, 700-volt rectifier. The control and switchgear equipment do not include any bus tie switches or circuit breakers, and the three bus sections and their respective power supply rectifiers operate independently at all times. The motors are started and brought up to speed by phase shift rectifier voltage control, and are stopped by individual dynamic braking.

Each of the three 2920-kw and 3500-kw main power supply rectifiers consists of twelve pumped ignitron mercury arc rectifier tubes, and the twelve rectifier tubes, the vacuum pumping equipment, the water-to-water heat exchanger cooling equipment and the excita-

Figure 5 — Finishing mill has 3000-hp, double-armature motor "K"; 1500-hp single-armature motor "J" is coupled at the opposite end of the layshaft.



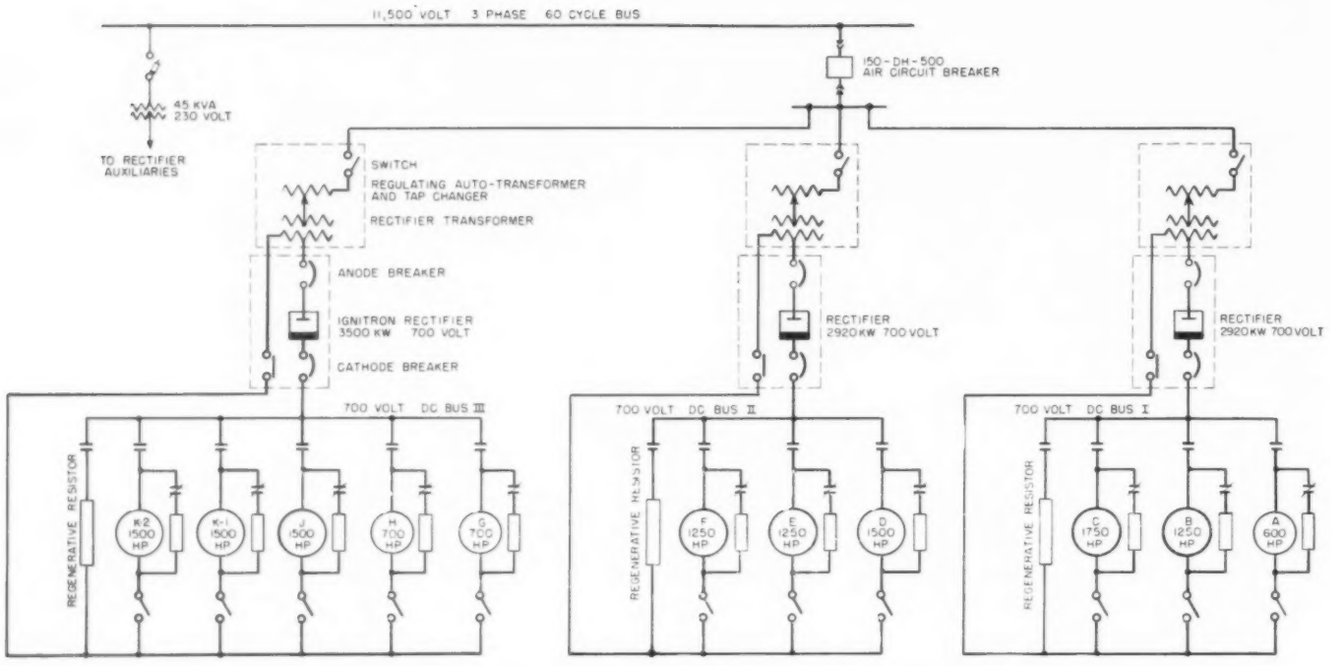


Figure 6 — Schematic diagram of main connections, rod mill main drive motors and power supply rectifiers.

tion equipment, are factory assembled in a dead-front metal-enclosed cubicle. The rectifier cubicle is of matching dimensions and appearance with the anode circuit breaker cubicle and the cathode circuit breaker cubicle, and the rectifier and associated anode and cathode circuit breaker cubicles are assembled together to form a co-ordinated rectifier unit substation equipment. Each of the three rectifier substations has over-all dimensions approximately 23 ft-1 in. long, 72 in. deep, and 106 in. high.

The three rectifier substations were shown along the right motor room wall in Figure 2, and Figure 7 is a view of the 3500-kw rectifier substation supplying the finishing mill, showing the cathode breaker and relay and voltage regulator compartments at the left, rectifier assembly in the larger center compartments, and anode breaker compartment at the right. The anode breaker and cathode breaker are of metalclad drawout truck construction so they may be withdrawn from the stationary structures for inspection or maintenance. Figure 8 is a view of the same 3500-kw rectifier substation with the center compartment doors opened to show the mounting of the ignitron tubes and vacuum pumping equipment.

The rectifier power transformers are outdoor type, oil-insulated self-cooled, with cable pothead entrance to the high voltage connection compartment, and with flanged throat connection around the low voltage anode and negative terminals. The three rectifiers, with their associated anode and cathode switchgear, are installed on the motor room floor which is about 14 ft above the mill yard level. The rectifier transformers are installed at the yard level, outside the motor room basement wall, so the anode and negative line leads from the transformers go horizontally through the basement wall and then up through the motor room floor to the rectifier substations. The mill motor line control panels are installed in the basement, separate from the rectifier substations, and each group of motor control panels controlling the roughing, intermediate and looping and continuous finishing mill motors, is installed adjacent to the motor foundation and supplied from its respective rectifier substation. Figure 9 shows the installation of the three outdoor rectifier transformers, together with the transformer for 440-volt auxiliary power supply.

The primaries of the three rectifier power transformers are controlled together from one 11,500-volt metal-clad air circuit breaker section. Each transformer has a no-load primary disconnecting switch in the high voltage cable entrance compartment so that any transformer may be disconnected during checking or other emergency operation, and the disconnecting switches are key interlocked with the 11,500-volt breaker so the switches may be opened or closed only when the breaker is open. Bushing current transformers are provided on the primary leads of each transformer to afford individual a-c overload protection of each transformer. The primaries of the two 2920-kw rectifier transformers are connected delta, and the 3500-kw rectifier transformer is connected wye.

The voltage of each main power supply rectifier is maintained by a magnetic amplifier voltage regulator. A common reference is provided for all three voltage regulators, so that the voltage of all three rectifiers can be varied simultaneously with the voltages remaining in correct proportion; also individual adjustment is provided, which makes it possible to maintain the same or different voltages on the three bus sections. The individual voltage adjusting rheostat for each rectifier bus section also varies the intelligence to the speed regulators for the motor supplied from that bus section, so the speed regulators maintain the motor speeds proportional to the bus voltage. The rectifier power transformers have capacity so that rated d-c output voltage can be maintained at up to 125 per cent load and with down to 95 per cent of rated a-c supply voltage.

Each rectifier transformer includes in the same tank a regulating autotransformer and a motor operated load tap changer which may be controlled either manually or automatically. The tap changer has seventeen positions

to change the rectifier nominal d-c output from 410 to 700 volts in sixteen equal percentage steps. Each step is about 3.4 per cent, which means that the nominal d-c voltage change per step varies from about 14 to 23 volts. Operation of the tap changer under rolling load conditions causes a transient voltage disturbance which persists until the magnetic amplifier voltage regulator can adjust the phase shift current to the value required to maintain the d-c voltage on the new tap, however, the voltage regulator response is very fast and the voltage and speed disturbances caused by a tap change are less than those caused by the load change when a bar enters or leaves the mill.

For automatic operation, the tap changer position is determined by the magnitude of the phase shift control current. The control operates the tap changer to maintain the phase shift current within a given band, the limits of which are adjustable but wide enough to prevent operation of the tap changer during normal load fluctuations. The automatic tap changer control is operative only when the master control rheostat is at the full voltage running position, so the tap changer remains at its last running position and does not operate during the starting and acceleration of the mill.

VENTILATION

All of the main drive motors are equipped with sheet steel rear enclosing covers, fitted to the bedplate, and arranged for updraft forced ventilation by blowing ventilating air into the foundation pits under the motors. Motors "A" to "G," which are installed in the motor room, do not have any front enclosing covers so the commutator and brushes are completely open and accessible, and the warm air is exhausted into the motor room. Motors "H," "J" and "K," which are installed out in the mill, have front enclosing covers to keep dirt from falling on the commutator, and louvered "venetian blind" openings are provided in these front covers to discharge the warm air.

The ventilation system is of the updraft nonrecirculating arrangement in which during normal warm weather operation outdoor air is drawn through electrostatic air cleaners, blown through the drive motors, and the warm air exhausted from the motor room through roof ventilators and other openings. Most such updraft nonrecirculating ventilation systems have only one set of fans, however in this installation the motors must be ventilated in different groups, and the basement is above yard level so that it was considered desirable to have the basement area at small positive air pressure to assure against dirt infiltration. Therefore the air cleaners are enclosed in a small basement room, and axial flow air intake fans are provided in the precipitator room wall to draw air through the precipitators and blow it into the basement to maintain the basement at moderate positive pressure. Centrifugal fans then take air from the basement and provide the pressure to blow the air through the motors. One fan supplies the air for motors "A," "B" and "C," a second fan supplies air for motors "D," "E," "F" and "G," a third fan supplies air for motor "H," and a fourth fan supplies air for the 4500-hp finishing mill drive "J-K." Automatic shutters prevent reverse flow of air from the "H" and "J-K" motors when they are shut down. Manually adjustable dampers are provided in the air

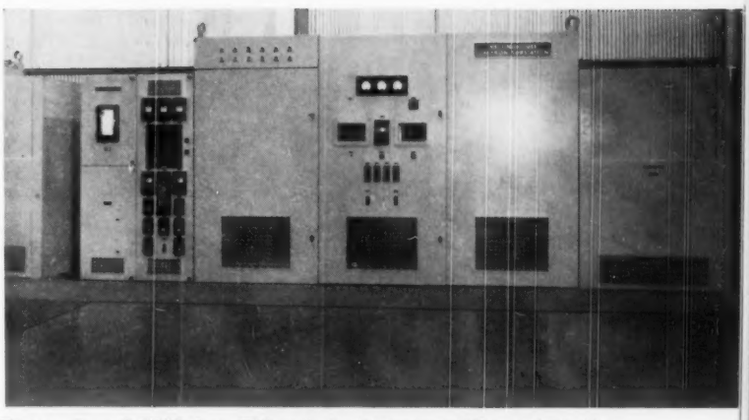


Figure 7 — A 3500-kw, 700-volt ignitron rectifier substation "III" supplies the finishing mill drive.

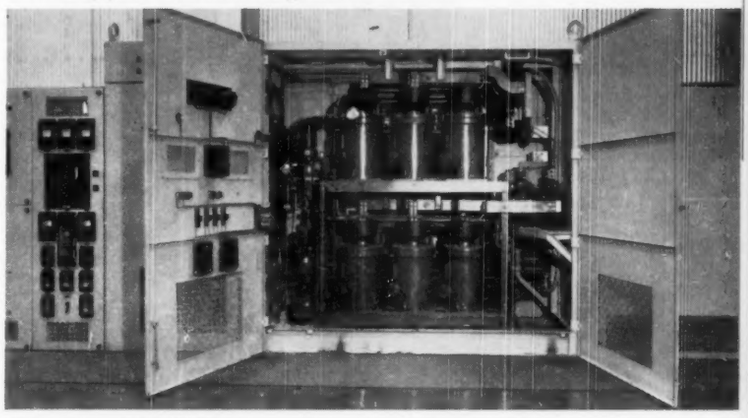


Figure 8 — The 3500-kw rectifier substation has doors open to show internal assembly.

intake so that during cold weather the outdoor air intake may be partly closed and warm air from the motor room returned to the intake, thus recirculating part of the air to maintain comfortable motor room temperature.

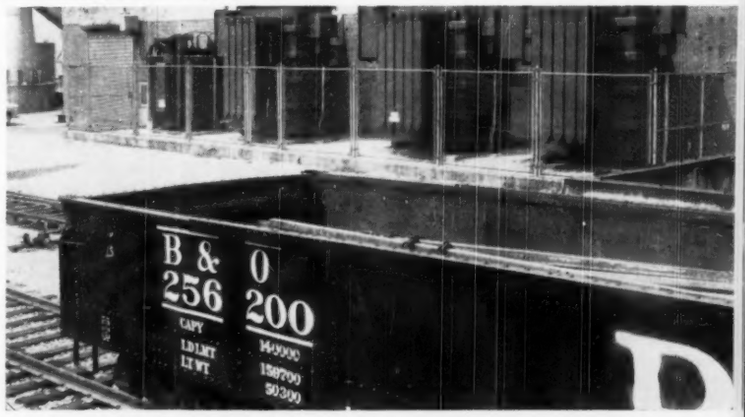
Figure 10 is a view in the basement showing the 120,000-cfm, precipitator room and six 17,500-cfm, axial flow fresh air intake fans.

Figure 11 shows the 23,500-cfm centrifugal fan supplying air to the roughing mill motors, also shows the main motor operated rheostats for motors "A" and "B."

OPERATING PERFORMANCE

A few typical brush oscillograph charts may be of interest in showing the performance of the electrical

Figure 9 — Outdoor rectifier transformers furnish 440-volt auxiliary power supply.



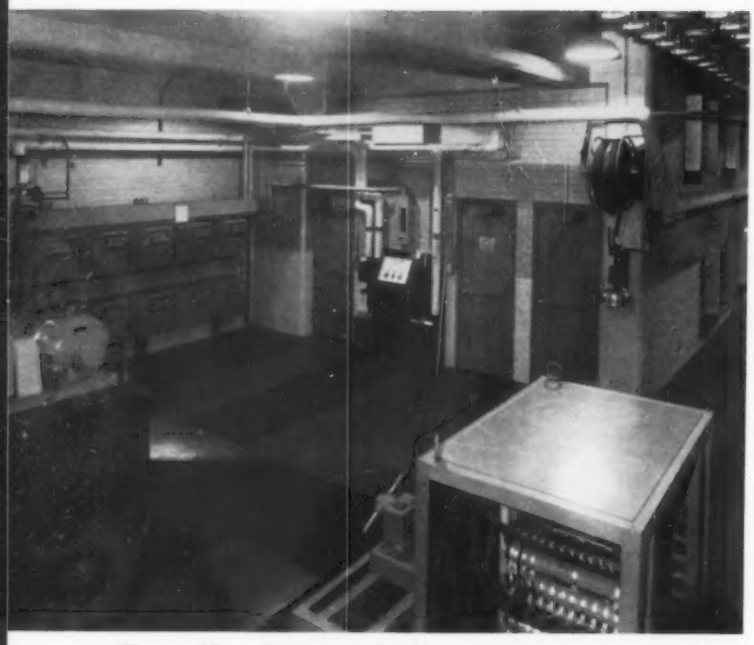


Figure 10 — Axial-flow fresh air intake fans are in basement, and can be seen on right.

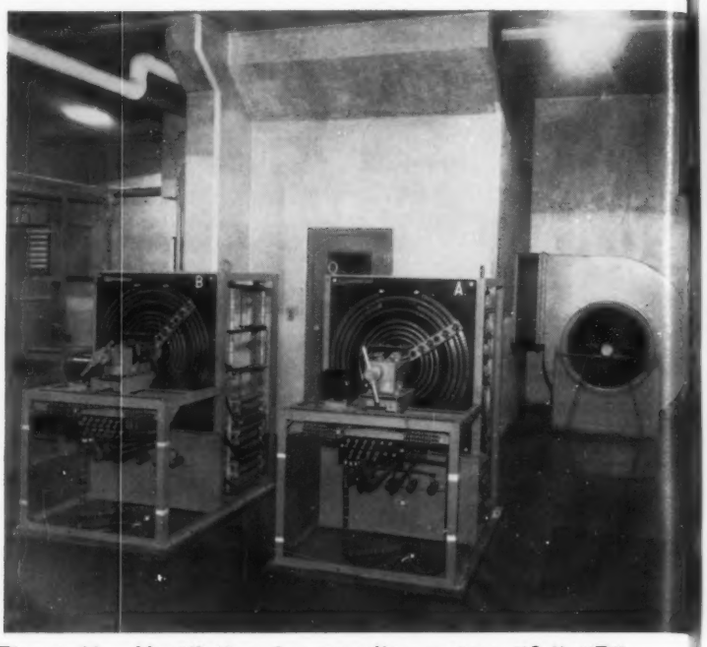


Figure 11 — Ventilating fan supplies motors "A," "B" and "C."

drive during normal rolling operation.

The first chart—Figure 12—shows the performance of the continuous finishing mill delivering No. 5 rod at about 6100 fpm, with the 4500-hp "J-K" drive running at 900 rpm and the 3500-kw rectifier "III" operating at 710 volts, and going from full four-strand operation down to one-strand and back up to normal four-strand production. The third trace from the top is the total current, approximately 3900 amperes with four strands, 3200 amperes with three strands, 2500 amperes with two strands and 1800 amperes with one strand, a change of 700 amperes for each strand. The top trace shows the change in speed of the "J-K" drive, and indicates an impact speed change of about 0.4 per cent when a strand enters or leaves the mill, with recovery to the running speed in about 0.8 sec, and very slight overshoot. Also the speed trace shows practically zero variation in the steady state speed from four- to one-strand operation. It may be noted that the operator made a manual vernier speed change of about 0.5 per cent at the right side of the chart. The second trace from the top shows the change in rectifier voltage, about 0.4 per cent total variation during the test period, and the bottom trace shows the rectifier phase shift current to maintain the rectifier voltage over the load range. It should be noted that the finishing mill consists of eight stands through which the rod passes in succession, so that the 700-amp load change per strand is not instantaneous but in increments at from 0.11- to 0.04-sec intervals and totaling a little less than ½ sec(0.45). This step loading has the effect of reducing the impact speed change but also prolongs the time for speed recovery.

Figure 13 is a section of an oscillograph chart showing the performance of the "D" and "E" intermediate mill drives while finishing 29/64-in. diam rod from the looping finishing mill, and going from normal four-strand operation down to three-strand and then back up to four-strand production. Traces 1 and 2 at the top of the

Figure 12 — Oscillograph chart of finishing mill drive rolling No. 4 rod at 6100 fpm.

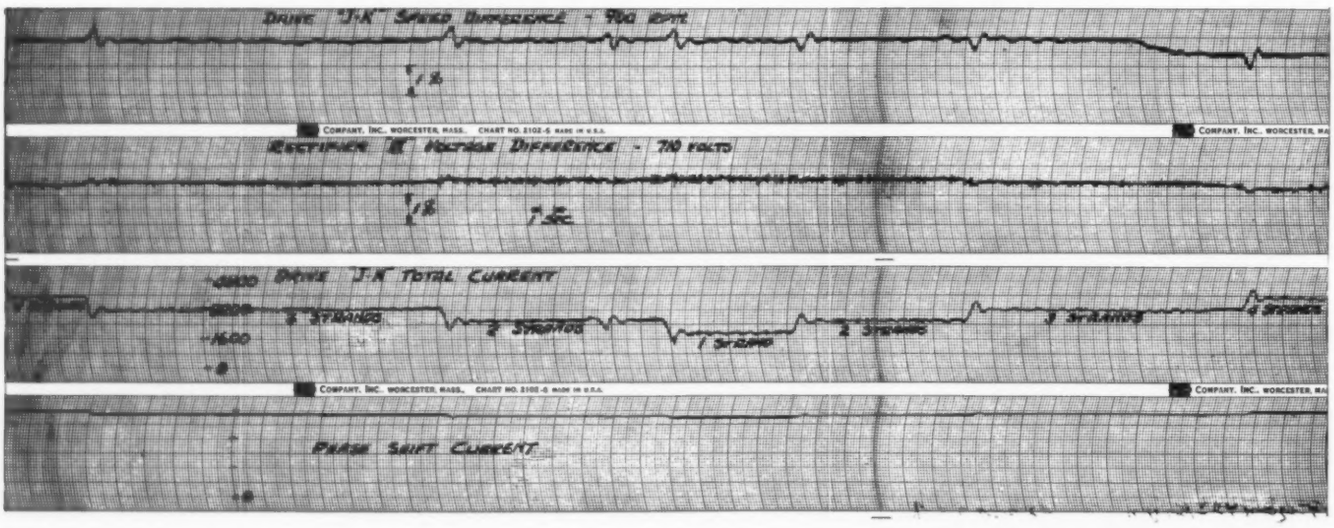
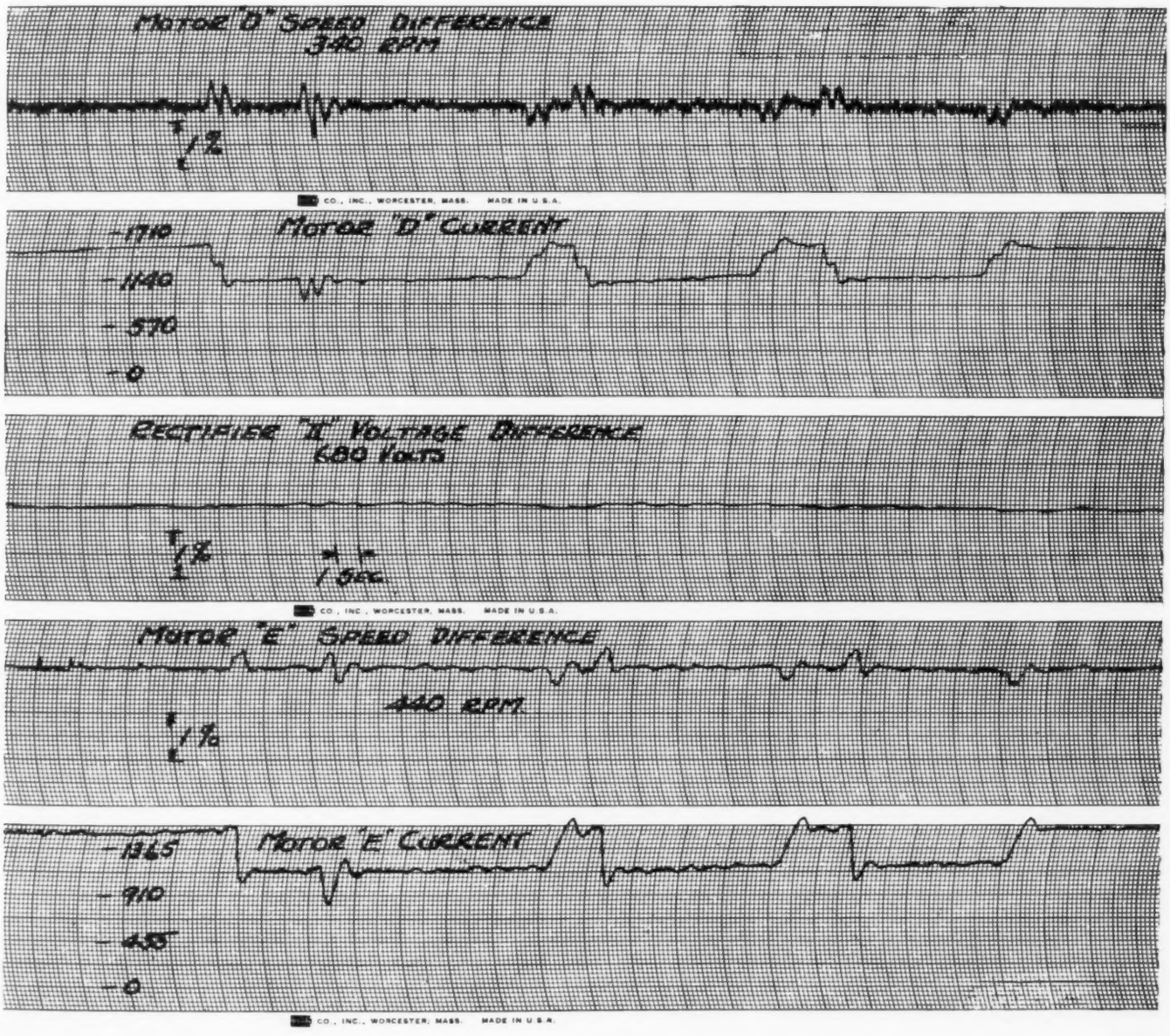


chart show the change in speed and motor current, respectively, for the "D" motor, trace 3 shows the rectifier "II" voltage, and traces 4 and 5 at the bottom of the chart show the change in speed and motor current, respectively, for the "E" motor. Each motor drives two stands so the load change for each strand is in two steps. The spacing between stands No. 10 and 11, driven by motor "D," is somewhat greater and the bar is traveling at slower speed, so the time interval between No. 10 and 11 is about 0.6 sec and the motor "D" completes its speed recovery from the stand No. 10 load impact before the bar enters stand No. 11. The spacing between stands No. 12 and 13, driven by motor "E," is shorter and the bar speed higher, so the speed interval between No. 12 and 13 is only about ⅓ sec, so that the strand enters No. 13 before the motor speed has recovered from the stand No. 12 load impact, and the impact speed change for the two stands appears as a single disturbance. Again the steady state speed regulation over the load cycle is practically zero on both drives, and the impact speed changes are less than 0.4 per cent.

The oscillograph chart in Figure 14 shows the performance of the 2920-kw rectifier "I" and roughing mill motors "B" and "C" during manually controlled operation of the tap changer on the rectifier transformer. Traces 1 and 2 at the top of the chart show the changes in speed and motor current, respectively, for 1250-hp motor "B," trace 3 shows the rectifier "I" voltage change, traces 4 and 5 show the changes in speed and motor current, respectively, for 1750-hp motor "C," and the last trace at the bottom of the chart shows the phase shift current to maintain the rectifier voltage during the load cycle and transformer tap change. Each tap corresponds to about 3.4 per cent change in nominal d-c voltage output, however the voltage regulator response is sufficiently fast that the momentary voltage change is less than 1 per cent and recovery time only 0.1 sec, with correspondingly small change in motor speeds. During this test, the voltage was set at about 675 volts with more than normal phase back so the rectifier would have capacity to maintain this voltage after moving from tap No. 17 to tap No. 15.

Figure 15 is a section of oscillograph chart taken at quite slow speed over a period of several minutes to show

Figure 13 — Oscillograph chart of intermediate mill drives "D" and "E" finishing $^{29}/_{64}$-in. rod.



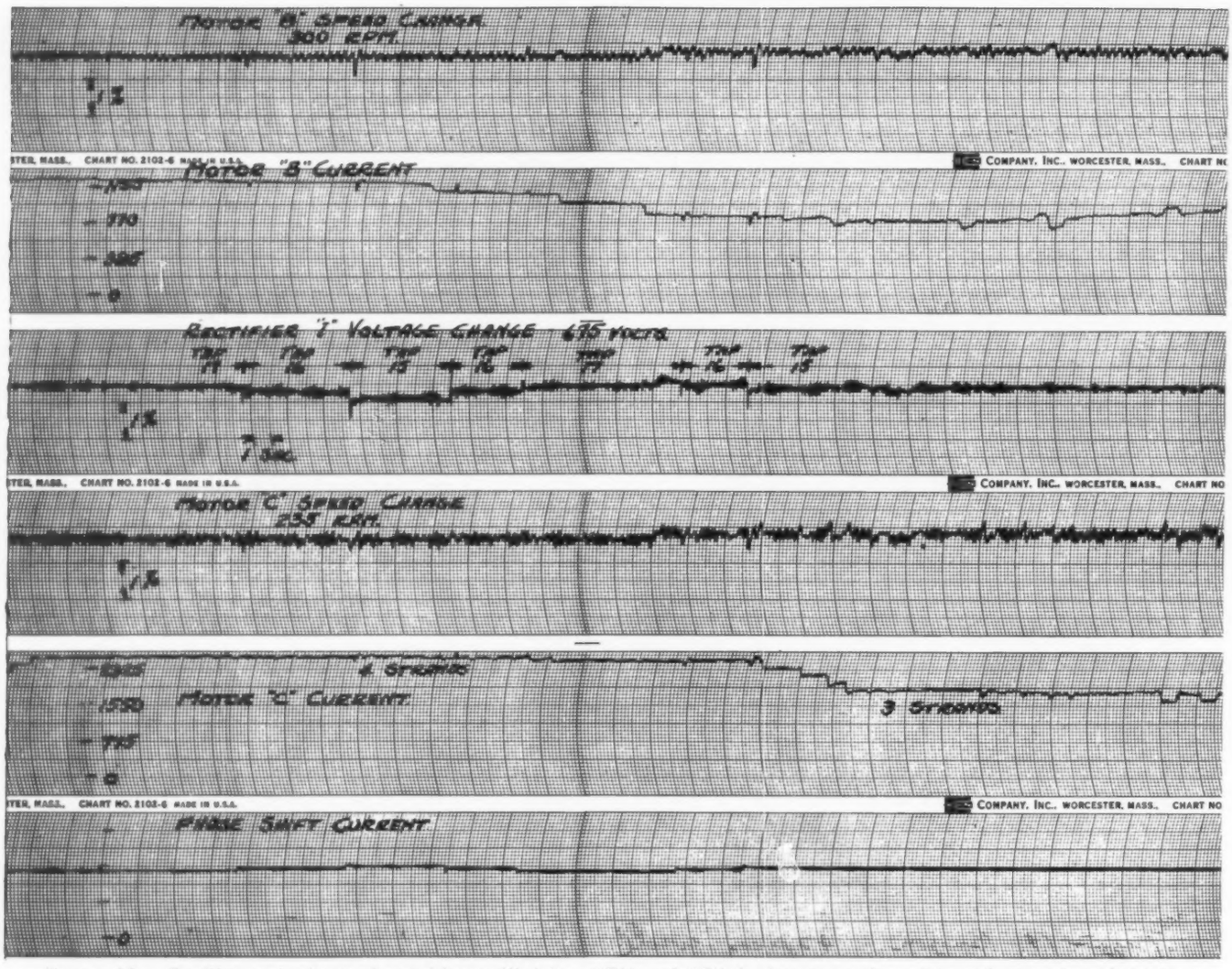
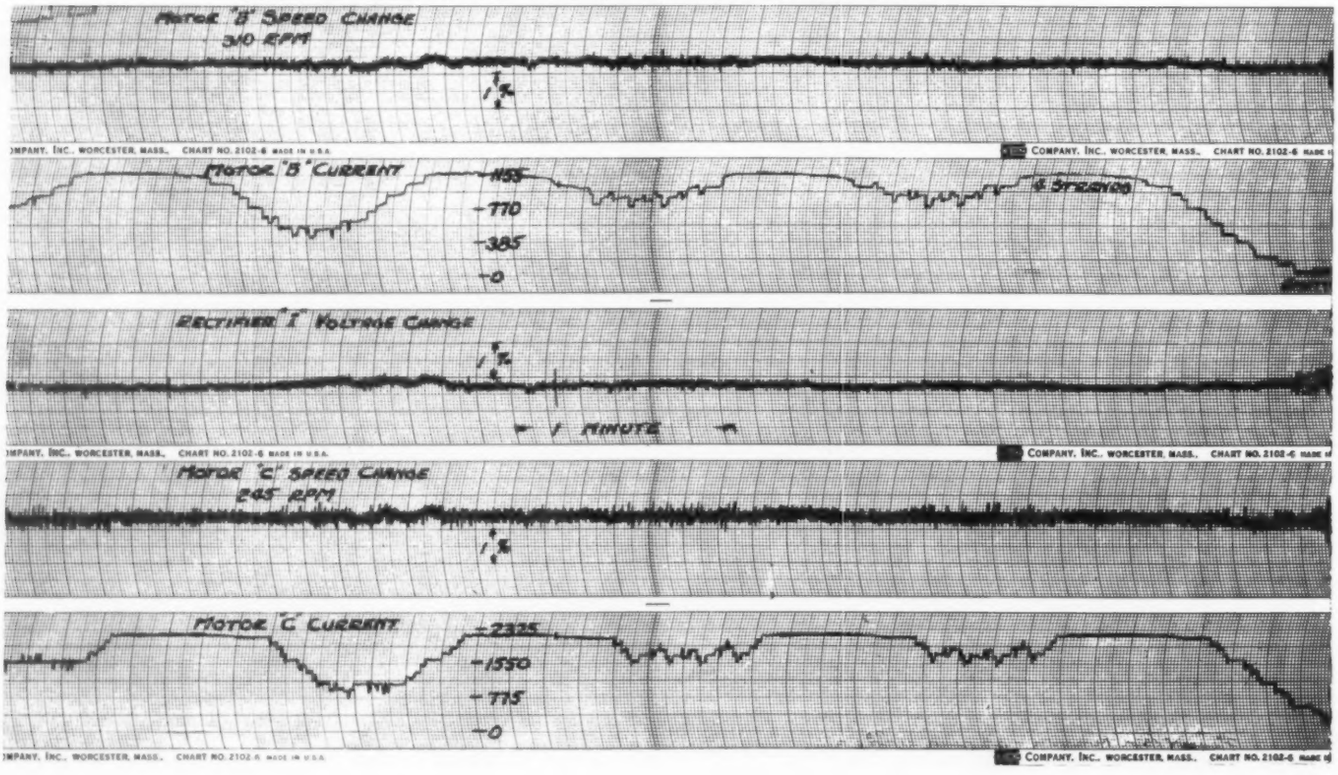


Figure 14 — Oscillograph chart of roughing mill drives "B" and "C" during operation of transformer tap changer.

Figure 15 — Slow speed oscillograph chart of roughing mill drives "B" and "C."



the performance of roughing mill drives "B" and "C" during several rolling cycles. The traces are the same as shown on Figure 14, except not showing the rectifier phase shift current. During this entire period, the total speed change on motor "B" was less than 0.6 per cent and on motor "C" about 0.8 per cent, and rectifier voltage change only 0.5 per cent. There apparently was one small manual vernier change in rectifier voltage with corresponding motor speed changes to adjust the roughing mill with respect to the intermediate mill.

MAIN DRIVE CONTROL

The successful operation of the electrical equipment for the main drive of a high-speed multiple strand continuous rod mill requires co-ordination of design of transformers, switchgear, rectifiers, control and motors in order to obtain optimum over-all performance. In other words, here is an outstanding example of what is today called systems engineering.

The choice of motors is the first major consideration. For some of the drives, three different frame size designs were analyzed to obtain a machine with electrical and mechanical characteristics which, in conjunction with its speed regulator, would have the desired low impact drop and fast speed recovery. Motor field design and speed regulator elements were chosen after an extensive analog computer study. Switchgear and control circuitry were carefully co-ordinated. The automatic tap-changer-under-load control actually is an integral part of the rectifier and swtichgear design. Rectifier voltage and motor speed regulators are tied to each other by the common reference and also through the d-c power bus. No one item can be considered as an isolated unit; each must be co-ordinated with all parts of the entire system.

After the equipment was manufactured, one complete unit—from transformer to motor—was tested in combination. Figure 16 gives a view of the test floor area

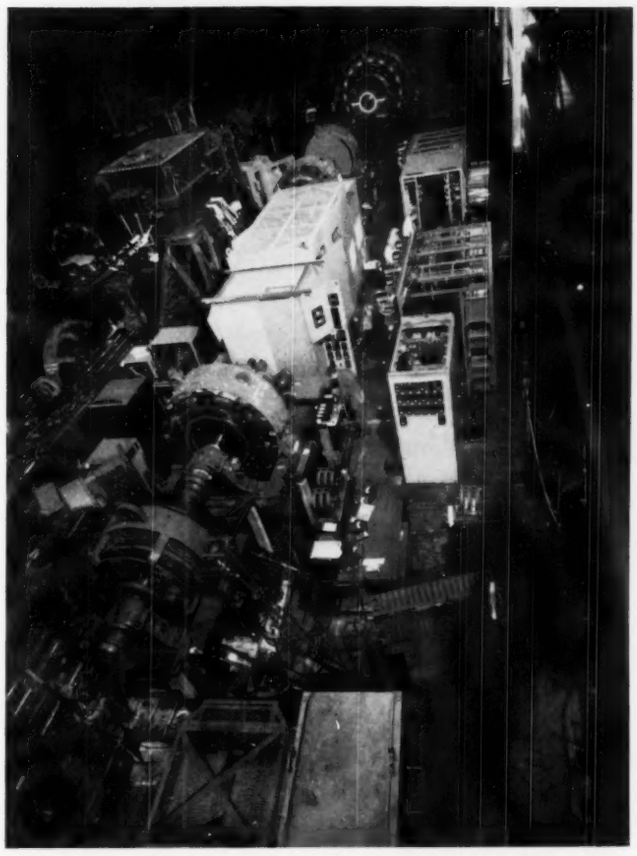
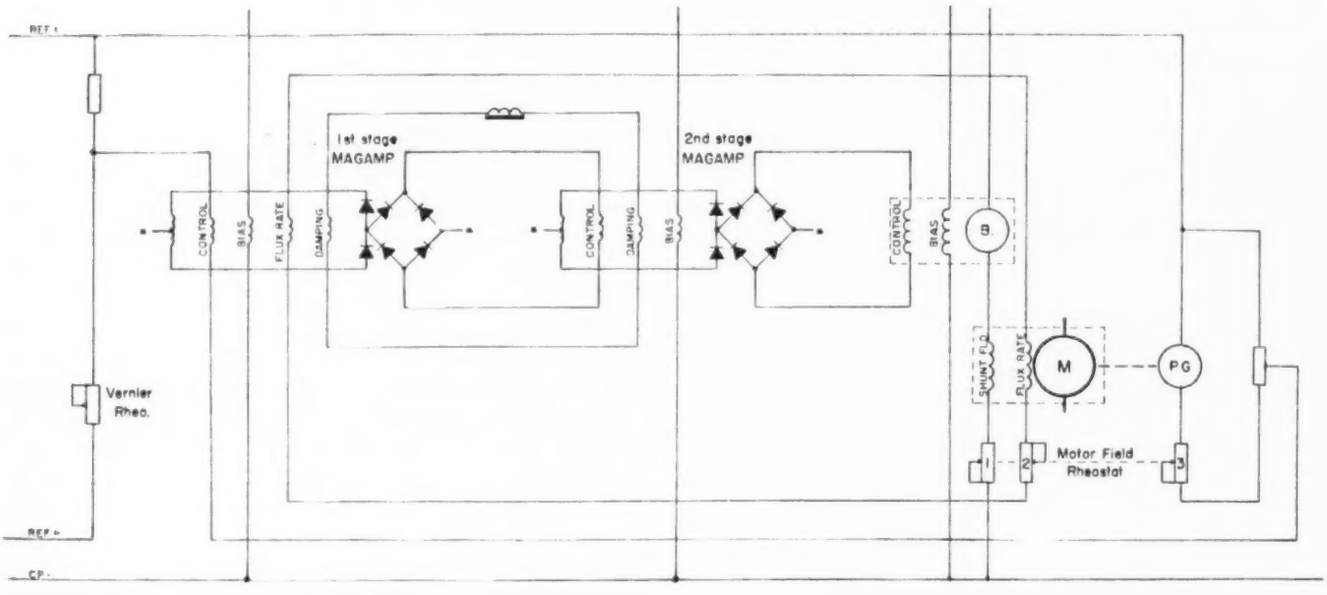


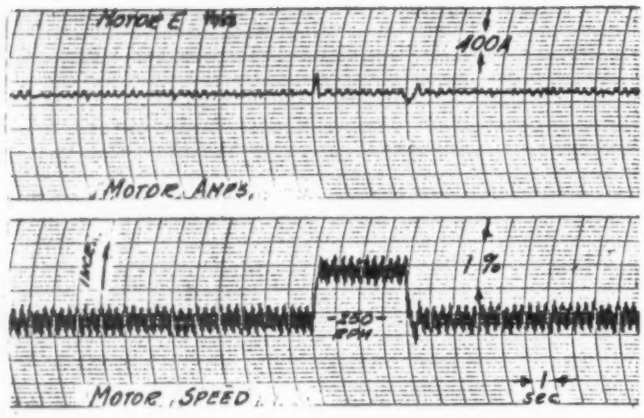
Figure 16 — General view of the combination test of the main drive power and control equipment at the factory.

during the combination test. In the left foreground is the 700-hp, 200/680-rpm motor "G" coupled to a test machine for loading purposes. The rectifier substation, including the ignitron tanks, and anode and cathode breakers, is located beyond the motor. The rectifier transformer is near the top left of the picture, and the

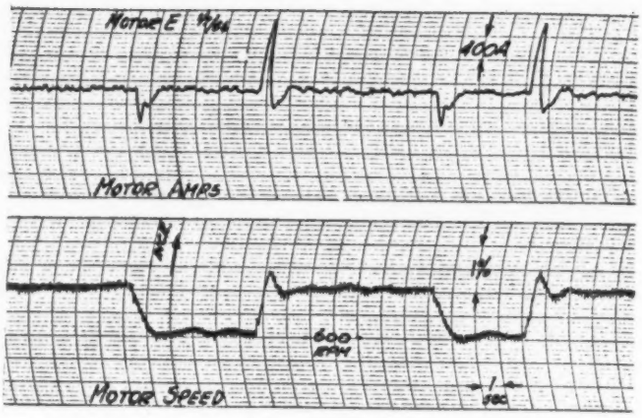
Figure 17 — Simplified schematic diagram of speed regulator.



M Motor
B Booster
PG Pilot Generator
* to 220V 400~ Supply



CURVE I



CURVE II

CURVE III

Figure 18 — Oscillograph shows typical speed regulator response.

control panels and operator's station are opposite the rectifier substation. This factory test in general verified previous computer studies; it also brought to light certain shortcomings which were corrected before shipping the apparatus to the customer, thus saving time, expense and annoyance at installation. But most important, this combination test permitted a comparison of actual impact load responses with regulator response to reference changes. Final adjustments of all speed regulators were made to obtain response to reference changes which corresponded to optimum performance under impact load; in other words, regulator adjustment prior to mill start-up could be and was completed to a degree where no further change proved necessary after rod was put through the mill.

The voltage of each rectifier is regulated by a magnetic amplifier voltage regulator which controls the excitation of a saturable reactor in the firing circuit. The speed of each motor is regulated by a magnetic amplifier speed regulator which controls the excitation of the motor field through a field booster. Magnetic amplifier power supply is a 50-kva 400-cycle alternator.

Because of the poor inherent voltage regulation of the alternator, its voltage is regulated by a magnetic voltage regulator. This voltage regulator receives its power from the very same machine which it regulates. Initially the alternator field is momentarily connected across the d-c constant potential bus; as armature voltage increases and the magnetic amplifier is excited, alternator field excitation is transferred to the magnetic amplifier output. Rectified alternator voltage is compared to the constant potential supply voltage; any difference between the two appears across the magnetic amplifier control winding causing a change in alternator excitation to reduce the difference. Response of this regulator is very fast, on the order of 0.05 sec, and to an accuracy of better than ½ per cent.

A master reference exciter supplies a voltage reference signal to each of the three voltage regulators and to each of the nine speed regulators. The shunt field of this master reference exciter is controlled by a motor operated rheostat so that the reference voltage to all twelve regulators is raised together.

Each rectifier transformer has a load tap changer with seventeen tap positions to permit operation from 700 volt direct current down to 410 volts. As tap position is changed, the reference to the voltage and speed regulators of the bus section must be lowered proportionally. This is accomplished by means of three bus-section voltage-lowering rheostats which are motor operated. The voltage of any one rectifier can be adjusted independently of the other two units.

The circuitry of the rectifier voltage regulator is quite simple. The magnetic amplifier control winding is excited by the difference between the reference voltage, as determined by the position of the voltage-lowering rheostat, and a voltage proportional to rectifier bus voltage. Magnetic amplifier output is fed into the d-c winding of a pair of saturable reactors in the rectifier firing circuit. A change of four amperes causes a phase shift of 120 degrees—a change from zero to full output of the rectifier. Any difference between reference voltage and rectifier voltage causes a change in magnetic amplifier output in a direction to minimize this difference.

The voltage lowering rheostat for each bus section also supplies the reference voltage to the speed regulators for the motors supplied from that bus section. This reference is compared to the voltage of a pilot generator coupled to each main drive motor. Refer to Figure 17. The difference between these two signals appears across the control winding of the first stage magnetic amplifier, is amplified in the second stage magnetic amplifier and fed into the control field of the motor field booster. Both magnetic amplifiers are single-phase, single-channel and are biased to operate around the midpoint of the straight line portion of their transfer curves. The normal output of the second stage excites the booster control field. Its flux is balanced by that of the booster bias field. Hence, normal booster output is zero but can be varied to buck or boost to adjust the main drive motor field strength to maintain the selected speed.

Motor speed is set by the position of the motor operated motor field rheostat. As motor field strength is varied, that portion of pilot generator voltage which is fed back to the speed regulator must be recalibrated to compensate for the change in speed. Thus as long as motor speed matches the position of the field rheostat, no current will flow in the control winding of the first stage magnetic amplifier. Any mismatching between rheostat circuits 1 and 3 is corrected by the speed regulator. Another circuit (No. 2) on the motor operated field rheostat is connected in series with the flux rate damping loop to vary the amount of damping over the motor field range. A second damping loop has been provided between the two magnetic amplifiers.

Figure 19 — Magnetic control panels for the looping and finishing stand motors.

Vernier adjustment of motor speed is accomplished by a small rheostat which recalibrates the reference voltage fed into the speed regulator. Response to a reference step change is shown on curves I and II of Figure 18 for low speed and high speed of motor "E."

Curve III of Figure 18 shows the performance of motor "C" as one strand enters and leaves stands 6, 7, 8 and 9.

Recovery time to impact drop varies from 0.25 to 0.5 sec depending on motor and field setting. Steady state speed accuracy is better than ¼ of one per cent.

Since rectifiers permit transfer of power in only one direction resistors must be provided to absorb the stored energy of a motor when its speed is lowered. The resistor on each bus is connected to the bus by means of a contactor whenever a motor speed is lowered. The contactor remains closed as long as motor current flows in a regenerative direction.

Emergency reversal of motor rotation is possible at jogging speed and is accomplished by reversing the motor field. Protective relaying prevents field reversal except when the motor is at standstill and prohibits reverse rotation above jogging voltage.

CONTROL EQUIPMENT

Location of control equipment can be divided into four major areas: motor room, motor room basement, mill area and operator's pulpit.

The field booster and exciter motor-generator sets, motor-operated rheostats and magnetic control panels are located in the motor room basement. Figure 19

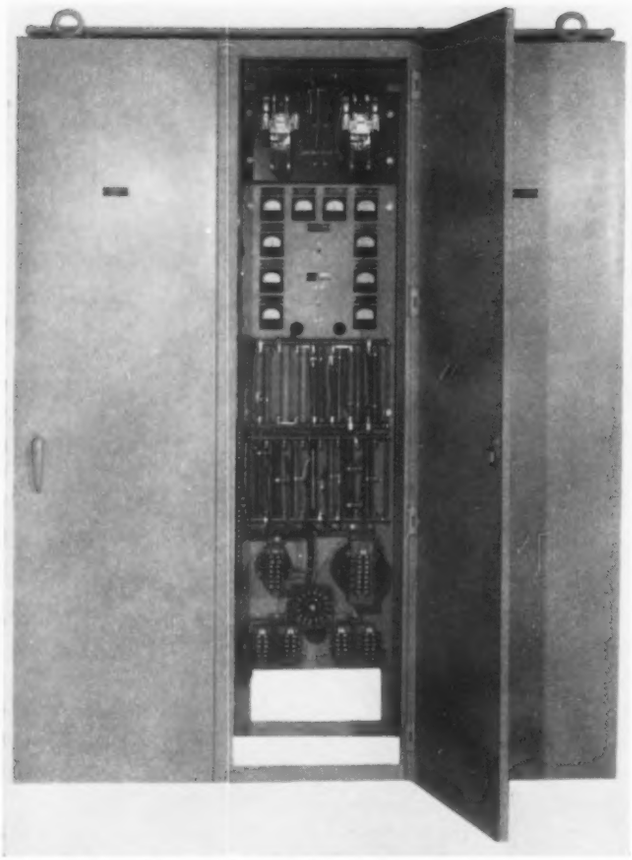


Figure 20 — Magnetic amplifier motor speed regulator panel.

shows the control panel section for motors "G," "H," "J" and "K." The panels on the right represent the entire magnetic control for one motor ("G") including main line contactor, dynamic braking contactor, overload relay, field contactors and miscellaneous protective relays. The fifth panel from the right mounts the contactors for the decelerating resistors, and various control relays associated with the control of bus section III. The six panels on the left are for the triple-armature motor "J-K." Control transfer switches have been provided to permit operation with any two of the three armatures. Also note the hook-stick operated negative line disconnects in the bus work along the ceiling. These switches were chosen in preference to panel mounted disconnects because of greater safety and more economical bus layout.

The magnetic amplifier regulator and metering master board is located centrally in the motor room to permit startup, shutdown and observation of the recording instruments of the main drive equipment from one location. This master board is of enclosed back-to-back duplex construction with access to the inside through doors at either end. The magnetic amplifier speed regulators are located along the back of the structure. Figure 20 gives a view of a magnetic amplifier speed regulator panel as seen from the rear of the master board. Note the complete instrumentation of all regulator circuits to facilitate testing at time of installation and checking of the regulator operation. Line terminal blocks, adjustable resistors and rheostats and magnetic amplifier terminals are all accessible from the outside of the cabinet so that personnel need not work inside the structure where space is restricted. The magnetic amplifier rectifiers are readily accessible for inspection from the inside of the cubicle.

Indicating and recording instruments have been concentrated on the front of the master board Figure 21. Also located on the front of this unit are motor line contactor and cathode breaker permissive switches, starting switches for all ventilating fans and exciter sets, heater switches, anode and a-c breaker switches, tap-changer operating and operation transfer switches, and the reset button for the rectifier master lockout relay. In addition, the mill annunciator and the control devices for the constant potential exciter and the 400-cycle alternator are mounted here. This concentration of instruments and control switches permits the motor room attendant to control and survey the operation of the entire main

Figure 21 — Main drive master control board.

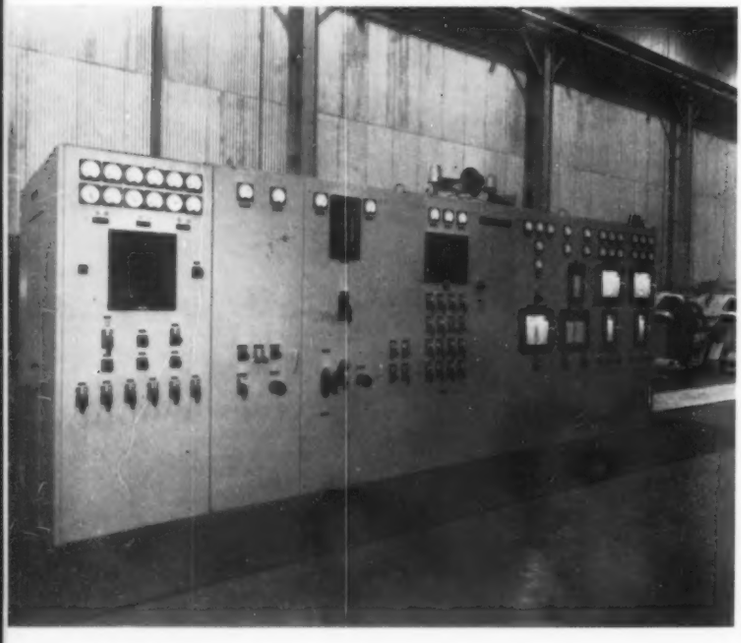


Figure 22 — Main mill control pulpit has benchboard with 13 sections.

drive from one central location.

The operator's control benchboard in the mill pulpit, Figure 22 consists of nine motor sections, three rectifier sections and one master section. Position indicators for the motor operated rheostats for motor field control and bus voltage lowering, and tap position indicators for the three transformer tap changers permit the pulpit operator to preset bus voltages and motor speeds before actually accelerating the mill. Normally, the mill is operated under automatic tap-changer control. The operator merely sets the voltage-lowering rheostat to the desired position; after the mill has been accelerated, the automatic control will move the tap changers on the rectifier transformers to the proper positions to insure best voltage regulation and power factor.

Indicating ammeters for control current of the rectifier firing circuits have been provided to enable the operator to use his judgment in the selection of rectifier tap position when this circuit is under manual control. Cathode breaker operating switches give the operator full control to energize the d-c bus or to open these breakers as a safety precaution during shutdowns.

The motor control sections on the operator's desk are grouped in three sets for three motors each, all of which are duplicates except that the vernier rheostats for motors "A," "B" and "C" are located on the furnace delivery desk on the mill floor. Three indicating instruments—ammeter, speed indicator and rheostat position indicator—have been provided for each motor. In addition there are two control switches, one for the motor line contactor and the other for motor field reversal. The latter also acts as a permissive switch, allowing the operator to remove any one motor from its bus. Indicating lights tell the operator at a glance which motor is connected to its bus, and for which direction of rotation.

The motor speed vernier rheostats are of vertical handle operating design and permit a total speed change of about 10 per cent. Because of the quick response of the motor speed regulators, the operator has excellent "feel" of each motor so that all speed corrections can be made quickly and accurately.

Each of the three motor sections of the control desk also has an emergency stop pushbutton for that particular section, a control switch to permit voltage lowering, and a jog pushbutton. Operation of the jog pushbutton results in inching of those motors which have their contactors closed, and in the direction for which they have been selected. Jogging is accomplished with the motors at full field for maximum torque at a low regulated voltage.

The mill master control is very simple. It consists of a master control switch with which the entire mill can be accelerated, or stopped, and the master emergency stop pushbutton, operation of which will cause all motors to be stopped by disconnecting them from the line and applying dynamic braking.

As rod delivery speed is increased, two-control design criteria assume greater proportions: The response of the drive to the operator's control and to load changes, and the accuracy at which given conditions such as speed are maintained. The ease with which the operators of this mill maintain correct roll speeds and make speed adjustments is proof that these criteria have been successfully met.

Discussion

PRESENTED BY

THOMAS A. BLOODWORTH, Supervisory Engineer, Electrical Application Dept., Industrial Equipment Div., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

A. J. WHITE, Steel Mill Engineering, Systems Application Engineering Section, General Electric Co., Schenectady, N. Y.

JOHN GREINER, Application Engineer, Electrical Application Dept., Industrial Equipment Div., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

A. F. KENYON, Advisory Engineer, Industry Engineering Dept., Westinghouse Electric Corp., Pittsburgh, Pa.

H. J. OAKES, Consulting and Application Engineer, Industry Engineering Dept., Westinghouse Electric Corp., Pittsburgh, Pa.

Thomas A. Bloodworth: It is not often that anyone in our position can be as familiar, or feel as familiar, with equipment put out by competitors as we do on this installation. It was a desirable order and all electrical manufacturers tried to obtain an order. In the course of preparation of our proposal, we did considerable engineering work, making a lot of studies on the analog computer.

We studied the use of three types of regulating systems, 60-cycle, 400-cycle magnetic amplifiers and electronic speed regulators. We feel from these studies that our friends made a wise choice in going to the 400-cycle. It is always desirable to avoid the use of extra equipment unless it can be fully justified. We would have liked to use 60-cycle because 60-cycle power is available and the use of 400-cycle regulators entails additional equipment.

However, the studies showed that there would be a considerable improvement in the usage of a 400-cycle, magnetic amplifier as compared to the 60-cycle. Due to the stringent requirements of a multi-stand rod mill, we felt that it would be advantageous to go to this additional complication.

The usage of electronic regulator showed a slight improvement over the 400-cycle. However, the improvement was so slight that we, and apparently Mr. Kenyon's company, who, I am sure, also checked electronic regulator, felt that the use of a device requiring less maintenance and insuring of better continuity more than outweighed the small advantage that would be gained from going to the electronic devices.

A. J. White: Mr. Kenyon and Mr. Oakes have presented an interesting paper on electric equipment for a type of mill which lately has been receiving a great deal of attention. Our company has also furnished electric equipment involving speed regulators, for several mills of this same type, one being a three-strand rod mill for the Johnstown plant of the Bethlehem Steel Co.

It would appear from the simplified schematic diagram of the speed regulator presented in this paper, that the programming of the d-c open loop gain of the over-all regulator is tied in rather inflexibly with the recalibration of the pilot generator voltage as the

motor is operated over its shunt field speed range.

As the schematic shows, both recalibration of the pilot generator voltage and the d-c system gain are accomplished by dial section 3 of the motor operated field rheostat.

In the speed-regulator circuit in use by our company, these two functions are kept separate by utilization of two separate dial sections of the motor operated field rheostat. One dial section programs the reference voltage to the regulator as a function of motor speed by shunt field control. This is in addition to the programming of reference voltage as a function of motor speed by rectifier voltage as mentioned by the authors in this paper.

In this case no bridge circuit is necessary across the pilot generator, since the full pilot output voltage is matched against the reference voltage over the complete speed range. Since there is no loading on the pilot generator, except for small error signal currents, the accuracy of the feedback element is improved and the drift is minimized. This is important since a feedback control system, is no better than the accuracy of the feedback element.

The second dial section in our control programs the d-c gain of the over-all regulator, and as a separate dial section can be built flexible enough to offer a wider range of adjustments, both for total ohms available and also for the taper of ohms vs per cent travel of the motor operated field rheostat. This flexibility is desirable since each motor and regulator have different gain characteristics over the motor shunt field range.

This second dial section was also utilized to program a lead-lag stabilizing circuit which proved very effective in the field weakening range of the motor in adding additional stabilization with no decrease in the system response.

In connection with the speed-regulator circuit presented in this paper, I would like to ask the authors if the booster exciter is a laminated machine. The authors have also pointed out that the motor shunt field design and speed regulator elements were chosen after an extensive analog computer study.

In the computer studies undertaken by our company on speed regulators, we found that a standard motor shunt field design could be utilized. The studies showed that it was always necessary to have one relatively long time constant for stabilization purposes, whether it be the shunt field itself or the first time constant in a rate feed-back circuit. I would like to ask the authors what their computer study indicated in this respect.

For a number of years our company has been using a static magnetic phase shifting circuit for the control of rectifier power supplies for mills of this type. I am not quite sure from the authors' paper, and I would like to ask them if this type of control is being used for this mill; or, if they are employing in addition to the magnetic amplifier voltage regulator, a selsyn type phase shifting device to obtain the 120 degrees phase shift for motor starting purposes.

John Greiner: It was interesting to hear about a four-strand, 6000-fpm rod mill as this undoubtedly is a harbinger of similar future mills. This being the case, we would like to inquire into C motor as it has been reported that this motor is carrying a pretty stiff load at times.

Would the authors care to comment on this motor, and its various loads?

A. F. Kenyon: It is interesting and gratifying that Mr. Bloodworth's studies gave results essentially coinciding with our computer studies as to the relative performance of different types of regulators. The desirable features of static magnetic amplifier equipment more than outweight the slight performance superiority of electronic regulators, and the demonstrated success of the magnetic amplifier voltage and speed regulators has certainly justified their selection.

Mr. Greiner has commented regarding the reported heavy loading of the "C" motor. The operators have determined that mill operation is improved by shifting some work from the earlier stands to the later roughing stands, so that the "C" motor loads are higher than originally contemplated. Thus far the reserve capacity of the motor has been adequate to carry the increased mill loads.

H. J. Oakes: Replying to Mr. White's comments, we have endeavored to achieve the greatest circuit simplicity consistent with satisfactory regulator response. The system as chosen proved relatively easy to adjust, and yet has sufficient flexibility to obtain the desired performance.

The motor field boosters are rotating regulator type machines, and operate at very low saturation. Satisfactorily low time constants were obtained by using annealed solid rolled steel frames, and the frames are not laminated.

The computer studies concentrated on the damping field of the motors. The main shunt field is of essentially standard design, with approximately 200 volt IR drop at full field.

The rectifier phase shift from 0 to 120 degrees is obtained entirely by static control means, and no mechanical phase shift is necessary. Starting and bringing the mill up to speed is accomplished entirely by raising the reference voltage. ▲

There is a constant demand for copies of "The Modern Strip Mill" published by the Association of Iron and Steel Engineers. If your copy is not in use please get in touch with us.

ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

No April Meeting

BUFFALO SECTION

Tuesday, April 8, 1958—Inspection Trip 1:30 P.M. Dinner 6:30 P.M., Meeting 8:00 P.M.

Inspection Trip: New Slabbing and Cold Mill Facilities, Steel Company of Canada, Ltd., Hamilton, Ontario.

"Operating and Electrical Features of New 46-In. Slabbing Mill at Stelco," by A. C. Gray, Superintendent of Bloom Mills and J. G. Mitchell, Superintendent of Electrical Dept., Steel Company of Canada, Ltd., Hamilton, Ontario, Canada

Dinner and Meeting—Steel Company of Canada, Ltd., Hamilton, Ontario.

CHICAGO SECTION

Tuesday, April 1, 1958—Dinner 6:15 P.M., Meeting 7:45 P.M.

"New Soaking Pits at South Works," by K. E. Dinius, Chief Engineer, South Works United States Steel Corp., Chicago, Ill.

Phil Smidt's Restaurant, 1205 N. Calumet Avenue, Hammond, Ind.

CLEVELAND SECTION

Tuesday, April 15, 1958—Data Not Available.

The University Club, 3813 Euclid Avenue, Cleveland, Ohio

DETROIT SECTION

Tuesday, April 8, 1958—Dinner 6:00 P.M. Meeting 8:00 P.M.

Election of Officers

"Mechanical Blast Cleaning of Carbon and Stainless Steel Strip," by Gilbert Dill, Senior Process Engineer, Wheelabrator Corp., Mishawaka, Ind.

Dinner and Meeting—Parlors E, F and G, Horace Rackham Education Memorial Building, Detroit, Mich.

LOS ANGELES SECTION

Monday, April 14, 1958—6:30 P.M.

"Solution of California's Water Problem," by Max Bookman, District Engineer, Department of Water Resource, Southern California Area.

Michaels Restaurant, 6309 E. Washington, Los Angeles, Calif.

PHILADELPHIA SECTION

Saturday, April 12, 1958—Dinner 6:00 P.M., Meeting 7:00 P.M.

"Recent Lubrication Experiences in the Sparrows Point Plant," by Thomas A. Bessent, Assistant Lubrication Engineer, Bethlehem Steel Co., Sparrows Point, Md.

"Air Pollution Situation Today with Special Reference to Control Legislation," by Allen D. Brandt, ScD., Chief Industrial Hygiene Engineer, Bethlehem Steel Co., Bethlehem, Pa.

Engineers Club, 1317 Spruce Street, Philadelphia, Pa.

PITTSBURGH SECTION

Monday, April 14, 1958—Social Hour 6:00 P.M.,

Dinner 7:00 P.M., Meeting 8:00 P.M.

"Gas Turbines for the Steel Industry," by J. O. Stephens, Section Manager, Industrial Gas Turbine Engineering Department, South Philadelphia Steam Div., Westinghouse Electric Corp. Philadelphia, Pa.

University Club, University Place, Pittsburgh, Pa.

ST. LOUIS SECTION

Wednesday, April 30, 1958—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Discussion on Steelmaking in Certain European Countries," by N. P. Veeder, President, and J. R. Britt, Chief Metallurgist, Granite City Steel Co., Granite City, Ill.

Elks Club, Granite City, Ill.

SAN FRANCISCO SECTION

No April Meeting

UTAH SECTION

Monday, April 14, 1958—Social Hour 6:30 P.M., Dinner 7:30 P.M., Meeting 8:30 P.M.

"Satellites and Guided Missiles," by S. S. Kistler, Dean, College of Engineering, University of Utah, Salt Lake City, Utah.

Grandview Cafe, 66 N. 54th West, Provo, Utah

YOUNGSTOWN SECTION

Monday, April 28, 1958—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Tomorrow Is Here Today" by R. C. Sollenberger Vice President, Conveyor Equipment Manufacturers Assn., Washington, D.C.

Dinner and Meeting, Mahoning Country Club, Girard, Ohio

Symposium on C. F. & I.'s Pueblo Plant

. . . . isolated more than most other steel plants, the Pueblo plant of The Colorado Fuel and Iron Corp. has to depend more on its own resources and personnel than most other plants . . . . this has affected some of the operating and maintenance practices . . . .

"PRODUCTION OF SEAMLESS CASING AND TUBING"

by MELVIN SUMRALL
General Foreman
Seamless Tube Mill
The Colorado Fuel and Iron Corp.
Pueblo, Colorado

CONSTRUCTION of the seamless mill at Pueblo was completed and production began in August, 1953. The mill is designed to roll seamless tubing (outside diameter under 4 in.) and casing of 4½- to 9⅝-in. outside diameter.

The following paper describes the equipment and its purpose in producing seamless casing and tubing which is used in oil well production.

In order to give as clear a picture as possible of the operations, the paper follows a steel round from the time it is received at the seamless mill until it has become the finished product. These operations are as follows:

1. Conditioning of the round.
2. Cutting the round to desired lengths called billets.
3. Charging the billets into a rotary furnace where they are heated to desired rolling temperature.
4. Centering of the billet.
5. Piercing of the billet.
6. Plug mill.
7. Reeling.
8. Sizing to produce casing.
9. Stretch reducing mill to produce tubing.

1. Conditioning of the rounds—The steel rounds received at the seamless mill have some cracks on the outside called seams, which must be removed before the hot operations begin, so the steel rounds are taken to the first of two conditioning units called a peeler. The peeler is a large lathe where ⅛ to ¼ in. of the outside diameter is removed, depending upon the depth of the crack. This peeling of the rounds has removed most of the undesirable defects but a few remain, so the rounds are then processed through the second and last of the conditioning units called scarfing. The rounds are inspected and then scarfed by use of the conventional hand torch method which will remove the remaining visible defects.

2. Cutting the round into billets—The rounds received from the peelers are from 22 to 30 ft long, depending upon the section to be produced, and since these lengths are much too long to be hot rolled into casing or tubing, they are cut into more workable lengths, called billets, by use of acetylene torches.

3. Charging and heating the billets—Before the hot forming of a cold solid steel billet can begin, it, of course, must be heated, and so the billet, after being cut to desired length, is taken to the rotary furnace. This rotary furnace is approximately 76 ft in diam and can handle a billet length of from 5 up to approximately 14 ft. The spacing between billets can be varied as well as the speed at which the billets travel through the three heating zones. This speed is regulated so that as the billet travels through the three heating zones, each of which increase in temperature, it will have sufficient time to become thoroughly soaked, or reach the same temperature, throughout. This usually requires about 15 minutes per in. diam to reach a desired rolling temperature of 2280 F.

4. Centering of the billet—After heating the billets to 2280 F, they are taken from the rotary furnace one at a time and placed on a conveyor line, which transports them to the centering machine. The centering machine operation consists of punching a cone shaped hole into the end of the billet approximately one in. in diam and one in. deep. This hole will aid in the piercing operation, which is to follow, by serving as a guide for the piercer point. In doing so, it decreases the possibility of the pierced billet having a thick wall on one side and a thin wall on the other, which is generally referred to as eccentricity.

5. Piercing of the billet—The centered billet now enters No. 1 piercer entry trough across rolldown tables where

it is pushed into the piercing mill by use of an air ram.

The piercing mill consists of two barrel shaped rolls, with a crown at approximately the center of their body, which rotate in the same direction. These rolls are also tipped from the horizontal, so as to make the speed, at which the steel feeds through the rolls during the piercing operation, adjustable. We also have a pair of piercing shoes, generally referred to as guides, which are used to restrict the flow of the metal and also to guide the billet during the piercing operation. The piercer point is a piece of steel alloy shaped like a bullet, which is inserted on the end of a retractable mandrel bar to hold it in place during operations. As the hot billet is pushed into the mill, the rolls grab the billet and begin spinning it over the piercer point, which is held in place between the rolls by the above mentioned retractable mandrel bar. This will produce what is no longer called a billet but a shell. This shell is now somewhat longer than the original billet and has a hole throughout its length and a fairly heavy wall. The shell now travels by conveyor to No. 2 piercer where it is again elongated, the wall decreased and the outside diameter increased. No 2 piercer operations are the same in principle as No. 1 piercer, so there is no need to repeat it.

6. Plug mill—Thus far a hot solid steel billet has been transformed into a shell of about 2½ to 3 times the original billet length with a hole throughout its length. The function of the plug mill is to obtain the desired casing wall as ordered. This is done by pushing the shell from No. 2 piercer into a two-high rolling mill which has an oval shaped pass design. A stationary bar is located in the center of the oval shaped pass and has provisions for the insertion of a plug mill pin with attached steel plug in the end of the bar. As the shell, which has a larger outside diameter than the dimensions of the plug mill pass, is pushed into the plug mill, it is grabbed by the turning rolls and pulled over the plug mill plug. Since the outside diameter of the shell is now subjected to the pressure and action of the rolls and the inside diameter of the shell maintained by the steel plug, the resultant steel wall between the two is decreased. This gives the desired wall and the shell is also elongated considerably because of decreasing the wall and outside diameter.

7. Reeling—The product is now a shell with a finished wall, but it is necessary to remove light inside and outside scratches. This is done on the reelers. The reelers, in appearance, are somewhat similar to the piercers, having two guide shoes, a retractable mandrel bar and a reeler plug. The cast iron reeler plug, which is usually about ¼ in. larger than the inside diameter of the shell, is held in place between the rolls by the above mentioned bar. The shell is rotated by two rolls turning in the same direction up over the plug, giving the shell a burnished inside diameter and outside diameter with a slightly larger outside diameter.

8. Sizing—The final hot operation on the mill consists of taking the reeled pipe either to a stretch reducing mill to make tubing, or to a sizing mill to make casing. The sizing operation in producing casing will be described first. The sizing mill consists of a series of seven stands of rolls with two rolls per stand. These stands of rolls are inclined 45 degrees from the vertical with every other stand inclined 45 degrees from the vertical in the opposite direction. As the shell passes through each of the seven stands, its outside diameter is reduced until finally the desired casing outside diameter is formed in the last two stands.

9. Stretch reducing mill to produce tubing—As mentioned above, a reeled shell of desirable outside diameter, usually 6 in., can be taken to a stretch reducing mill to produce tubing (under 4 in. outside diameter) instead of casing in a sizing mill.

Located in front of the stretch reducing mill is a furnace where the reeled shells, usually 44 ft long, are conveyed for reheating before the stretch operation begins. The reeled shells are reheated to approximately 1800 F. The stretch reducing mill consists of 16 stands of rolls in series. There are two rolls per stand which are inclined at 45 degrees as mentioned under sizing mill discussion. Each of the stretch mill stands are individually driven with provisions for varying the rpm either up or down. Let us assume that we are going to make tubing of the following dimensions: O.D.—2⅞ in.; length—110 ft; and wall—0.217 in. The reeled shell needed to produce this tubing in the stretch mill would be approximately as follows: O.D.—6 in.; length—45 ft; and wall—0.275 in. This reeled shell, after reheating to 1800 F, passes through the series of 16 stands, and since the pass dimension of each stand is smaller than the preceding stand, the outside diameter is reduced to 2⅞ in. At the same time of the outside diameter reduction, it is necessary to decrease the 0.275 in. wall to 0.217 in. This is done by applying tension on the hot shell and stretching it between stands. Due to the outside diameter reduction taking place, the rolls of each stand have a firm grip on the shell and by increasing the rpm of each stand above that of the previous stand, tension is applied, the shell is stretched and the wall is decreased. The decreased wall and outside diameter results in a tube, approximately 110 ft long. This is then cut into three lengths by hot saws.

After completing the final hot operation in the production of casing (sizing) and tubing (stretch and reducing), they will then pass across cooling beds before going to the finishing floor for final processing, such as straightening, inspection, cropping ends, upsetting, threading, final inspection and coating.

"INSTALLATION OF STRETCH REDUCING MILL"

by HOWARD L. MITCHELL

Design Engineer

The Colorado Fuel and Iron Corp.

Pueblo, Colorado

AS the operation of the seamless tube mill approached its rated capacity it became apparent that the tubing sizes 4½-in. outside diameter and smaller were preventing the mill from attaining its expected tonnages. The mill production varies from 100 to 150 pieces per hr for all sizes, consequently when running tubing, the tonnage is greatly reduced.

From an analysis of sizes and tonnages it was decided to install a stretch reducing mill which would utilize 6 in. shells from the reelers, the same shell is commonly used for 5½-in. casing. By this change, the much higher

tonnage of the mill on the larger sizes could be utilized since each shell would make three to four pieces of tubing depending on the size. The 16-stand stretch mill has a rated capacity of 150 shells per hr reducing to 2⅜- to 4½-in. outside diameter.

The mill as selected was a mill of 16 stands, each driven by a 200-hp, 600-volt, low impact speed drop, d-c motor, 800 to 1700 rpm. All motors have individual speed control for setting and maintaining the required overspeeds for the proper stretch between stands. The first seven stands are on 15-in. centers with 14⅝ in. diam rolls, and the last nine are on 12½-in. centers with 12-in. diam rolls. This gives a length of only 17 ft-1 in. from the first to the sixteenth stand. The rolls are overhung for ease of changing sizes or replacing worn sets.

The control basement is pressurized with air drawn from outside, washed and filtered through a dry filter. The roll stand motors are forced-ventilated with recirculated and cooled air from the basement. The same type system is used for the motor-generator set. Fin type closed heat exchangers are used for this cooling.

The existing central lubrication system was used to lubricate the mill. Due to the length of pipe, it was necessary to pump the return back to the main tank. This is handled by two Automatic pumps operating from a 1000-gal reservoir.

The usual problems of material flow and interferences encountered when an addition is made to a mill were faced and the location as shown on Figure 1 was selected. As can be seen, the only conflict occurred at the discharge of the chain transfer to the 14-stand reducing mill. However, the large control basement had to be made to conform to the existing foundations. Sheet piling was driven at the sides of the more critical places to guard against shifting of the foundations. Two piers under the building columns had to be removed and much deeper ones poured in order to get enough room for the electrical equipment.

Over 6000 yards of earth were excavated and trucked out without disturbing normal mill schedules. All foundation work was completed and the machinery installed with the exception of the charging conveyor for the reheat furnace before the final run on the original 14-stand mill was finished.

At the end of this run, there were about three weeks in which to make the switchover. The 14-stand mill with its reheat furnaces and charging conveyor were pulled out and the chain transfer was increased from 35 to 48 ft in width to accommodate the longer shells necessary for the stretch reducing mill.

The stretch mill and its auxiliaries are set up for automatic operation. The reheat furnace is of the rolldown type with end charge and discharge. The hearth is 14 ft-0 in. wide x 52 ft-0 in. long and fired from the charging side by eleven burners. It is arranged for automatic temperature and pressure control, using either natural or coke gas. It has capacity to heat 140 shells per hr, 6-in. outside diameter x 0.244-in. wall from 1450 to 2050 F. The discharge can be controlled by the tubes leaving the stretch mill or by a manual push button.

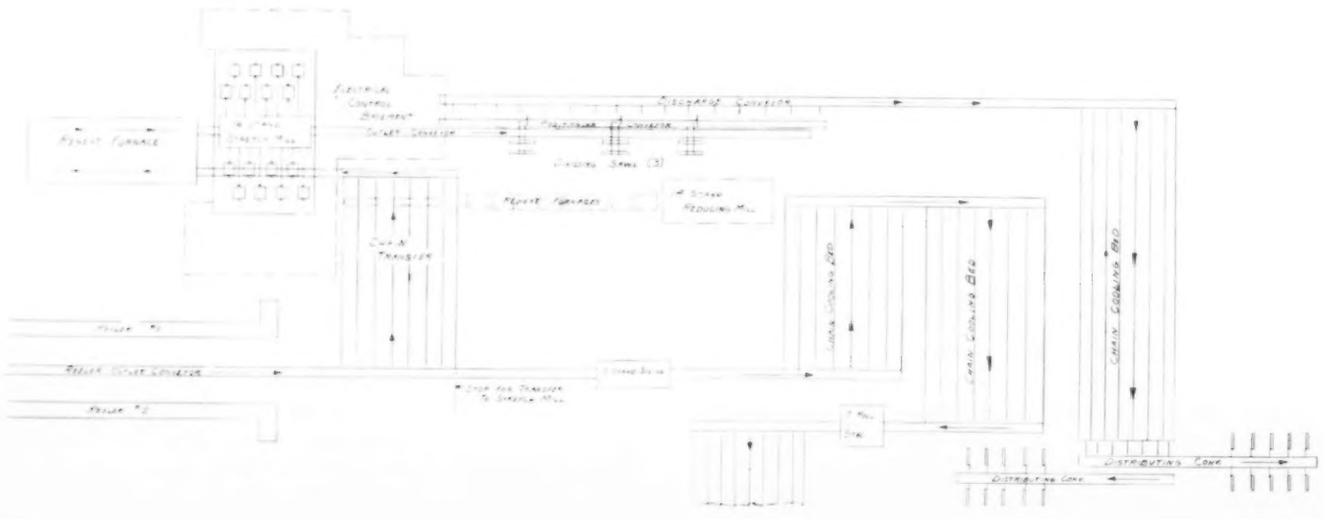
The stretch mill runout conveyor has V-type rollers, each driven by its own floating shaft motor-reducer, at 385 rpm, with a surface speed of 1030 fpm. A flag switch near the end automatically operates the motorized kick-off to the positioning conveyor. From the positioning conveyor, the tube is carried through the fixed position saws by a set of star wheels from which the cut lengths roll to the discharge conveyor. This conveyor is made up of four sections, having speeds of 430, 530, 640 and 750 fpm, to get sufficient separation between tubes to discharge them one at a time onto the chain cooling bed.

The chain cooling bed is 124 ft-6 in. long, using seven chains to transport the tubes into the next building for separation.

Due to the speed of the mill, especially on the 2⅜-in. tubing which is cut into four pieces, the separation had to be made automatic. This was handled by making two conveyors running in opposite directions. As the tubes come off the cooling bed they roll down a set of skids with gates to span the conveyors. The long end pieces contact a flag switch which opens an air-operated gate allowing them to drop onto the conveyor while the cut lengths cross this gate and drop onto the opposite conveyor.

At the end of these conveyors, there is a set of cradles on either side with star wheel kick-offs to distribute the

Figure 1 — Flow diagram for installation of 16-stand stretch reducing mill.



tubes. Provision is made in the control so that they may be sequenced, thereby separating the end pieces into two groups according to the end to be cropped. With this setup, a maximum production from the mill of over 600 pieces per hr up to 40 ft in length can be handled.

From the separation cradles, the tubes are handled by overhead cranes and placed in racks which are then transported by straddle carriers to outdoor storage areas for use as needed in the finishing department.

Due to the greatly increased capacity of the hot mill to produce the smaller sizes, the finishing department had to be revamped to handle this load. Where previously two 7-roll straighteners were in the line for continuous production, using only one machine at a time, these now were separated so that both machines could be used simultaneously. The larger machine remained in the casing line and the smaller machine was moved so that it now becomes the first operation in the finish mill line-up for the expanded tubing production.

In order to accommodate this tubing line, two sets of storage racks were eliminated.

The tubing is received from the outdoor storage areas by straddle carrier and transferred to the straightener charging bed. A star wheel kick-off was added to the outlet table to discharge directly to the first inspection station. At this station, the tubing can be sorted, rejected or sent by conveyor to the cutoffs.

Through cutoff, upset and threading, the tubes move in the original plan with no machinery added. However, these are now utilized more fully.

A new final inspection line was set up for sizes up to 5½-in. outside diameter and a maximum of 35 ft in length. This line includes a coupling starter, screw-up and drifter served by a single hydraulic transfer table, a scale and measuring device, hydrostatic tester and coating machine.

The scale and measuring device was placed ahead of the tester so that a close range could be held on the tester. By eliminating some of the movements of the carriage, the speed of the tester will be materially increased. All stenciling is completed at this station before testing.

The tester was designed to handle tubing and casing to 5½-in. outside diameter, 16 to 35 ft in length with test pressures to 7000 psi. This takes in the alternate test pressures for all API tubing of "J" grade. No "N" grade will be run over this inspection bed. All movements of the tester are manually operated with hydraulic valves while the test pressure and time are automatic. The test pressures are controlled by a closed hydraulic oil circuit, to the low pressure side of the intensifier, operated from a variable volume pump. The high pressure piston is 3¾-in. in diam with a 10-in. stroke giving a half gallon per stroke.

The coating machine is of the mechanical atomization type using four heads. The tubing is conveyed through the machine at a speed of 290 fpm. The kick-off from the outlet conveyor to the delivery bed is operated by a low pressure hydraulic reciprocating rotary actuator. By using this unit in place of a cylinder, there is no bother from the coating machine vapor being pulled into rod seals. The lubrication is handled by an oil-fog system so that all bearings are pressurized causing an air flow from inside the bearings to keep them clean.

Summarizing the effects of this addition to the mill, the hot mill production capacity was increased by the use of 6-in. shells through the stretch mill to produce all sizes 4½-in. and below. The increase came from the larger shell running at a higher rate than the small sizes and the multiple lengths through the stretch mill.

In the finish department a bottleneck around the straighteners was eliminated by moving the smaller machine. It is now possible to restraighten either tubing or casing to 5½-in. outside diameter at any time, and the large machine can be used for restraightening whenever the mill is on tubing sizes.

The final inspection and test has been improved by not having to make as many size changes. This will increase the capacity of the large tester and the tubing line will be run at a higher rate because all equipment is designed for the sizes to be run. The skids and cradles were designed for their most advantageous use in the manner in which the mill is operated.

"DOUBLE COOLING BED FOR ROD MILL"

by D. H. DRISCOLL
Industrial Engineer
and CLAIR RENBERG
Draftsman
The Colorado Fuel and Iron Corp.
Pueblo, Colorado

WHEN the rod mill was originally conceived and designed, its layout was such that either coiled rod or light bar sections could be produced by having the product move from the finish stand either to the reelers or to a cooling bed. The economics of the operation, however, did not at that time justify the construction of the cooling bed section, so immediate development was limited to rod production only.

Now, increased productivity on the mill has made available sufficient operating turns to take care of anticipated tonnage requirements of No. 3, No. 4 and No. 5 reinforcement bars. This available mill time coupled with the very favorable cost of production of these sections on the mill as compared to the 10-in. mill costs makes the cooling beds feasible at this time within two definite limits imposed by established rates of return necessary for approval of capital investments.

First, no conventional warehouse stocking facilities utilizing mill type overhead cranes and storage racks could be justified in the area. This made necessary the development of a method of handling light rebar up to 60 ft long between the mill and existing warehouse facilities in an efficient manner and at minimum operating and installation cost.

Secondly, it was necessary to design a bed which could be substantially manufactured in the Pueblo shops of the CF & I at reasonable cost.

This paper outlines how these two design requirements were solved.

A prime necessity for the successful operation of a mechanical cooling bed is that the rolled bar should be presented to it as straight as possible, and also, that the path of travel of the bar from the delivery stand to the bed should be as nearly linear as circumstances will

allow. Careful attention to the pass design and the setting of the mill rolls will insure that the majority of sections rolled will be delivered straight, and it is therefore essential that equal care and attention should be given not only to the operation, but also to the design of all equipment between the mill and the bed.

The double cooling bed is located at the continuous rod mill, and is on the south end of the mill where sufficient space is available for this expansion. Several types of beds were considered. However, since the bed was to handle rebar only and could be constructed for less than one-half the cost of a more flexible flat type bed, an escapement type bed was selected. The size of cooling bed with respect to the mill is governed by the range of bars rolled, weights of billets used and the maximum delivery speed from the mill, so that maximum yield of the billets is obtained. Production is limited by the holding furnace which has a heating capacity of about 60 tons per hr.

The continuous rod mill on which reinforcement bars are to be made has three strands, but for the new double cooling bed, only one or two strands are to be used.

Going back to the holding furnace, this discussion will follow each step of a 2½-in. square billet as it passes through each stand and comes out as a finished reinforcement bar. As the billet discharges from the holding furnace, it passes through nine roughing rolls continuously being squeezed in size and becoming longer in length. Then five intermediate stands succeed the roughing rolls, then the rod goes through two repeaters, finishing at stand No. 15 as a double strand. The delivery speed here is about 2000 fpm for ⅜-in. diam rounds. The bars pass through a covered roller trough onto an inclined runin roller table which carries the bar to the rotary shears. The speed of the inclined tables is greater than the speed in stand No. 15, therefore, accelerating the bar and moving it away from the oncoming bar. The rollers are slightly tapered to cause the advancing bar to hug the inside of the roller, and are mounted on specially and compactly designed motors having double rotor shaft extensions for this double bed. Roller speed for this table is about 2180 fpm. As the bars pass through the rotary shear and the front end of the bar reaches the photo-electric tubes, the heat from the bar causes the electronic relays to operate, which in turn, start the length of cut timer. These photo-electric tubes are placed above the roller outlet table of the rotary shear and are adjustable for desired length of bar to be cut. As the timer operates, it immediately starts the shear which accelerates to speed and cuts the bar. Just as soon as the cut has been made and the knives clear the bar, the shear will be regeneratively braked to a stop, reversed and returned to the starting position. This cycle continues until the rod has been cut up to desired lengths. As the bar is sheared by the rotary shear knives, the tapered rollers are increased in speed to approximately 2500 fpm or 20 per cent faster than the inlet table, forming a gap to separate the bars.

These runoff rollers are inclined to a height of 6 ft-7¾ in. above ground elevation. The table is 133 ft-2 in. long, and this section of the table is also covered, keeping the bar from running off the rollers in case there is a cobble. Here too, each roller is slightly tapered to cause the advancing bar to hug the inside of the roller and have the same double rotor type motors as used on the inlet table.

The next section of bed is the kick-off section extending 80 ft in length with each motor having a double rotor shaft extension for each roller. On this type of bed, the bar retains its full foward speed until its speed is braked on the surfaces of the straightening pockets. To deliver bars of the maximum possible length onto the bed, it is therefore necessary to commence the kick-off action before the advancing bar is fully on the cooling bed section. To do this, the kick-off mechanism and straightening pockets are extended at the entry end of the bed to the full length of the cooling bed.

The length of slide necessary to bring a bar to rest is not possible to calculate with absolute accuracy, but data received from various trials has developed a curve to predetermine the length of slide required for different diameter bars and various conditions. Factors involved in the computing of this curve would be the coefficient of friction between the reinforcement bar steel at mill delivery temperature and smooth machined cast iron straightening pockets.

The double kick-off mechanism consists of a horizontal shaft mounted above the rollers over the kick-off and cooling bed sections. On these shafts are clamped kick-off arms located at regular intervals, to sweep the bars off the rollers into the straightening pockets. The main purpose of the straightening pockets is to insure that the bar will be perfectly straight before it is deposited on the escapement rack. The position of the arms is directly behind the rollers, and 180-degree rotation of the shaft completes one cycle.

As the bar slides down the straightening pockets, it reaches the cooling bed area. The cooling bed is 270 ft long, with rollers mounted on each end of a double rotor shaft extension motor. The maximum length of bar received on this bed is 246 ft long and has a speed of 2180 fpm or 36.3 fps. Therefore, the kick-off arms must operate every 6.8 sec to clear the rollers for the oncoming bar. When the bar has been kicked from the rollers into the smooth surfaced straightening pockets, lifting fingers mounted on the escapement rack rotate up from under the apron plates, transferring the bar to the first notch of the escapement rack. The escapement racks are of cast iron bars set at an incline along the length of the cooling bed section. Each escapement rack has knobs spaced intermittently so that by rocking the racks in unison, the bars drop from knob to knob. These racks are mounted on a frame which runs the entire length of the cooling bed section. The racks are rocked in unison by a linkage, thus keeping the knobs in a straight line so that the bars lay straight during the cooling process. This is very important, because a warped bar could cause much delay on the racks, or later on in the final shearing. As the bars are dropped from knob to knob, they ultimately reach the shuffle bar section.

The shuffle bar mechanism consists of a series of flat bars, arranged in pairs, spaced at regular intervals along the entire length of the cooling bed section located between the discharge end of the cooling section of the bed and the runout table. At the cooling-element end of this mechanism, each bar forming a pair is mounted on an eccentric, adjacent eccentrics being

opposed at 180 degrees. The other end of each bar is mounted on a slide or pivot and is arranged to rise and fall a distance sufficient to raise the upper surface of the bars from a position below the runout table rollers to a short distance above it.

The rise and fall of the shuffle bars at the pivot end is operated by a 14-in. diam lifting cylinder which rotates the lineshaft with a movement of 80 degrees. On this lineshaft are mounted the slides or pivots spaced at regular intervals to accommodate the flat bars. Fixed stops are spaced along the length of the bed, adjacent to the runout table and the end of the cooling elements. The height of the stops is such that the tops are above the shuffle bars in the ambushed position, and below them in their elevated position. The rotation of the eccentric shaft in one direction or the other causes the bar resting on the shuffle bars to move towards or away from the runout table. When there are enough bars to form a batch, or when the preceding batch has left the runout table, the shuffle bars are lifted, and are walked forward across the fixed stops and lowered on the runout table.

The runout table for the double-sided bed consists of 16-in. diam rollers spaced at regular intervals along the entire length of cooling bed. These rollers are driven by a line-shaft with mitre gears. The length of the runout table is about 292 ft to the centerline of the cold finishing shear.

The location and speed of the cold finishing shear with respect to the bed is critical in that the bars must flow off the bed at a rate equal to, or greater than mill output to prevent production delays. Since a double cooling bed is utilized, two shears are provided at each end of the runout tables. Each shear is driven by a 25-hp motor and is capable of delivering up to 39 strokes per min and shearing 17 to 30 bars per stroke. Beyond the shear is located the 72-ft shear gage table with adjustable gage stops at 20, 40 and 60-ft measurements. These stops are pneumatically operated with controls located at the shear. After the shear cut is made, the stops are raised, and the bars run out to the end of the table where they are pneumatically kicked off into a surge cradle for accumulation into finished bundle size. The finished size is based on theoretical weights and has been standardized at 5000 lb.

This surge cradle presented a potential production bottleneck at maximum operating speeds, since a minimum shear and kick-off cycle of 12 sec must be provided for. This time certainly allowed for no tieing of the finished bundle in the cradle and a very marginal allowance for hooking crane cables around the material to clear the cradle. Therefore, a portable bundling cradle was fabricated consisting of a series of formed hooks suspended from a stiffener beam. This beam was in turn suspended from a small, ground-operated, double-trolley hoist. The bundling hooks are placed in slots under the permanent surge cradle while the bars are accumulating to a standard bundle weight. The hoist is then actuated and the hooks move upward through the cradle picking up the bars and clearing it within three sec. The bars during the transfer are confined to a semi-round shape which is desirable for the tieing operation.

From three to seven ties of $1\frac{1}{4}$-in. x 0.035-in. steel strapping are next placed on the bundle with pneumatic tensioners and sealers. These air tools quickly pull the bars into a compact, nearly round unit. The final step in the operation is the disposal of the bundle. This is accomplished by conveying the bundle backwards away from the shears to one of six straddle carrier bolsters located under the crane runway for each shear. The bundling hooks are lowered over the high side of the bolster's sloped deck so that as the hooks drop away, the bundle slides to stops, or to a preceding bundle on the bolster's lower side. This allows for complete loading of the bolster, which has a 40,000-lb capacity, without the need for spreaders.

The use of straddle carrier handling rather than the conventional railroad car was made necessary by several circumstances. The excess capacity on the mill was primarily available during the slack demand period for rods, but since both rebar and wire product sales peak during the same season, it became necessary to stock the bulk of rebar production for later sales. And further, a large percentage of rebar sales are to a fabricator located within the plant. Since no additional warehousing facilities could be justified with the beds, the problem resolved itself to one of intra-plant handling to existing stocking and shipping facilities.

A straddle carrier system for intra-plant product handling has been utilized at Pueblo for the past two years. This method of handling has two distinct advantages over railroad movement. The first and foremost of these is an average favorable cost differential of $0.05 per ton. The second is the speed and convenience of delivery, since the carriers are radio-dispatched and available on 5-min call. Approximately five sec are needed for the machine to pick up or release a bolster. Since no railroad trackage was needed for the installation of this system, a considerable construction cost reduction was obtained. Application of the straddle carrier system then solved the final storage facilities problem with the carriers replacing loaded bolsters with empties and transporting the loads to the present storage and shipping warehouses where the bolsters are unloaded with conventional overhead cranes. One carrier with a capacity of 60 tons per hr is to be regularly assigned to the operation with others available on call to handle surges if necessary. Between 20 and 30 bolsters are ultimately to be provided, which will allow sufficient temporary storage capacity in case of unloading difficulties to stock slightly better than an entire turn's production at maximum output. Incidentally, the cost of these bolsters is approximately $\frac{1}{12}$ of that of a railroad car, while their capacity averages $\frac{1}{3}$ of a car.

Total operating force on the bed is scheduled at 13 men. This number is also used for handling coiled rods behind the mill and will make scheduling of the mill relatively simple in either case. This small a force was made possible only by automating manual operations wherever possible, either completely, as at the rotary shear, or partially by supplying pneumatic muscles to replace manpower as in the bundling cycle.

The addition of these beds has not only insured short range returns as claimed on the financial "make-good," but also promises long range benefits through the increased flexibility of production potential on selected types of light bar sections on the high-speed, modern, rod mill. ▲

Development of Automatic Thickness Controls for Strip Mills

by I. G. ORELLANA
Project Engineer
Electrical Laboratory
Republic Steel Corp.
Cleveland, Ohio

. . . . most new mills under construction are using schemes which will automatically aid in obtaining better thickness control . . . there are many variations in the applications . . .

SINCE the introduction of the continuous strip mill, the idea of automatic control for the production of uniform thickness strip has been given widespread consideration. Numerous plans have been suggested for automatic controls to be applied to both hot and cold strip mills. From the results to date, it is obvious that automatic strip thickness controls for cold mills are simpler to work out than those for hot mills. Practically all steel strip producers now have systems of one type or another to provide automatic strip thickness control on cold strip mills, but similar controls on hot strip mills are in either the planning stage or at most in the preliminary experimental stages.

Republic Steel Corp. is no exception.

In its five strip producing districts there are six hot strip mills, including a 98-in. wide mill, plus a variety of single stand and multiple stand cold-reducing mills. Automatic strip thickness controls are operating on two large multiple-stand cold mills and three more are soon to go into operation. To date, there are no automatic controls for strip thickness control on hot strip mills.

The control systems in operation on the cold strip mills have been developed over a period of years, partly by instrument manufacturers who offer similar equipment to all steel producers, and partly by corporation personnel working in the various engineering departments, service departments and the electrical laboratory.

In the cases where instrument manufacturers have supplied the control equipment, it has been necessary to integrate the efforts of technical personnel in several different groups to make such control equipment a practical installation suitable for steel mill service.

The rolling of steel into strip is a process beset by many problems—steel analysis, slab size, slab surface condition, slab temperature, mill speed, strip tension and condition of mill rolls—to name a few.

While normally mills are not operated to produce the strip shown in Figure 1, off gage strip can lead to the same end—the scrap pile.

Strip thickness control starts at the hot strip mill. Until the introduction of the non-contact x-ray thickness gage in 1947, the standard practice in determining strip thickness was the use of hand micrometers on the edge of the last wrap of a coil after it had been delivered from the strip coilers. This is a hot and hazardous job, usually done in a hurry on a section of strip which is not representative of the whole coil. It also is a case of "locking the barn after the horse has been stolen" since nothing can be done to correct the thickness of strip in that coil if it is not on gage.

The installation of an x-ray thickness gage immediately following the last stand on a hot strip mill gives the roller thickness data on the strip as it is being rolled and while he can still make corrections on the mill to give the required thickness. Even though this correction is not automatic, it is still the first step in strip thickness control.

In 1948, Republic installed a non-contact, x-ray thickness gage on the Cleveland 98-in. hot strip mill (Figure 2). This mill rolls strip from 29 to 92 in. wide in thicknesses down to 0.049 in. at speeds to 1700 fpm.

Following the installation of this gage, rejections on hot rolled sheets for off-gage dropped from 1.83 to 1.09 per cent.

Similar hot strip mill installations have been made on the 48-in. hot strip mill at Youngstown and the 42-in. mill at Warren. The new 54-in. hot strip mill at Gadsden is similarly equipped.

All these installations only measure strip thickness. They do not include any automatic control.

For automatic strip thickness control on hot strip mills, various systems have been proposed. Some have incorporated details for operating the mill screwdown on the finishing stands as the end of the strip leaves the first stands of the finishing train. Others have proposed various forms of tension control, or temperature control on the strip from front to back end to reduce strip thickness "run-down." Tension, speed, temperature.

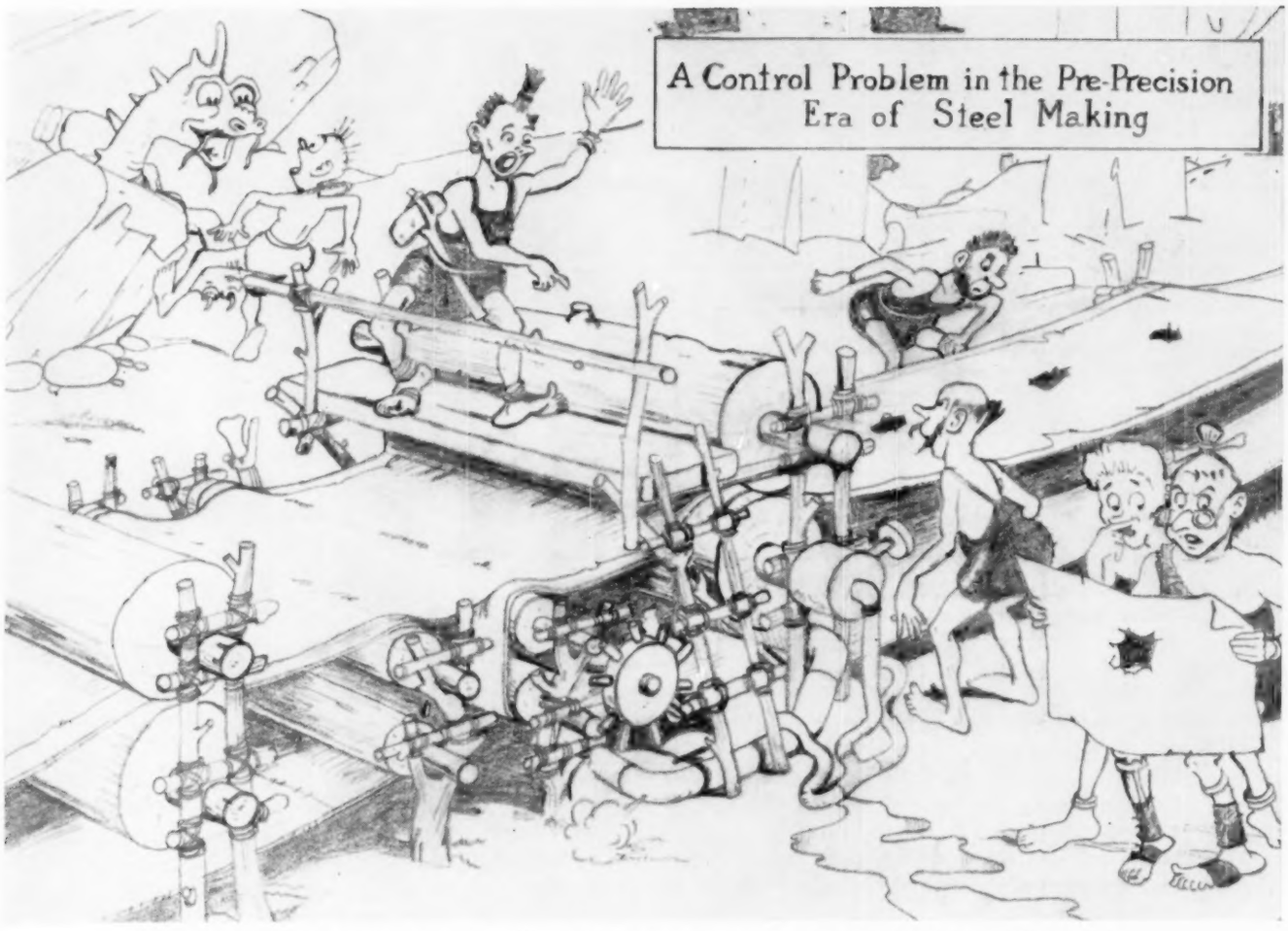


Figure 1 — Gage control in the rolling mill is not new as can be seen by this artist's sketch.

steel analysis, screwdowns and other variables all enter into the control of the thickness of hot strip.

In spite of the obvious need for automatic strip thickness control on hot strip mills, the complexity of the problem caused it to be deferred in preference of automatic thickness control on cold strip mills. It was felt also that the development of an automatic cold strip mill control would provide valuable background experience to be applied to a hot strip mill control later.

An installation of automatic screw-down control was made on the first stand of a tandem mill (Figure 3) located at Niles in 1953.

This mill is a 36-in., 4-stand, 4-high tandem mill, rolling tinplate stock at speeds to 1500 fpm. Hot bands are delivered to this mill in thicknesses from 0.070 to 0.090 in. and are reduced to tinplate thicknesses down to 0.0088 in.

In this control, a radioisotope strip thickness gage (Figure 4) mounted on the delivery side of No. 1 stand operates the screw-down motor contactors to correct strip thickness in steps whenever the strip thickness exceeds preset limits. On this mill, these limits were set at ± 0.0005 in. These limits apply for any thickness delivered by No. 1 stand.

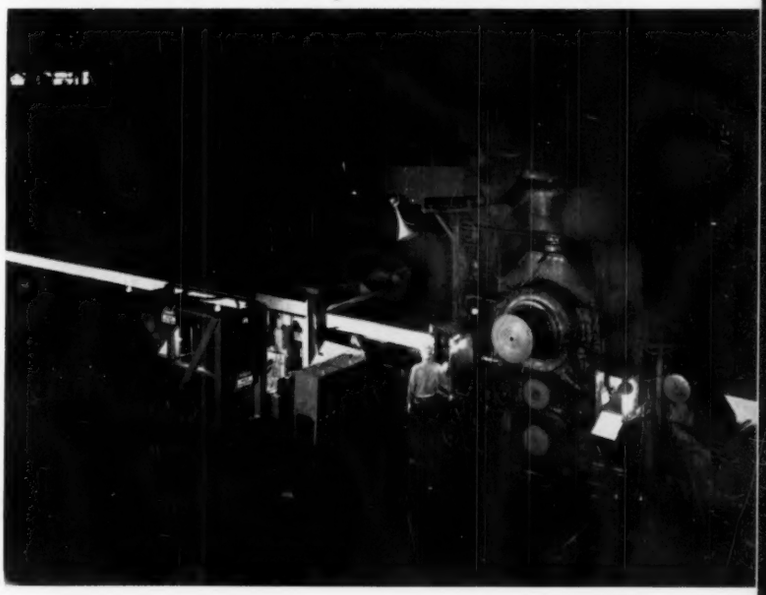
A similar installation, using an x-ray thickness gage is in service on the 98-in. cold strip mill in Cleveland.

In this system of strip thickness control, the first stand of the mill was chosen for various reasons:

1. At that point ductility is at a maximum. It is a pickled hot-band which has not been previously subjected to cold work.

2. The mill stand delivery speed is the lowest, permitting the most effective use of the screw-down motor network. Certain time delays are inherent in the screwdowns. They are due to contactor closure time, and acceleration of various mechanical components, gears, screws, etc.

Figure 2 — This non-contacting x-ray thickness gage was installed on the 98-in. hot strip mill at Cleveland in 1948.



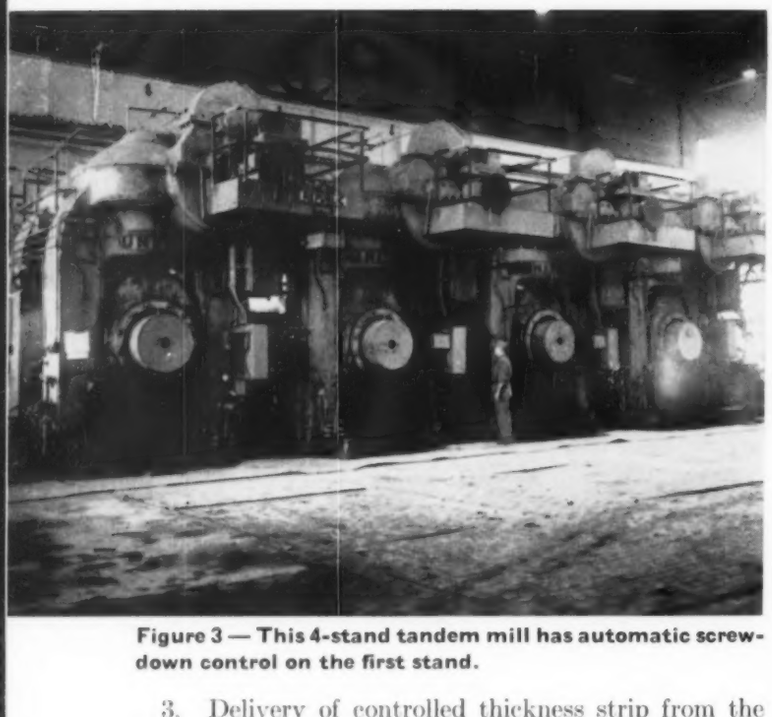


Figure 3 — This 4-stand tandem mill has automatic screw-down control on the first stand.

Figure 4 — The gage is of the radioisotope type.

3. Delivery of controlled thickness strip from the first stand reduces the difficulty of making uniform thickness strip on the other mill stands.

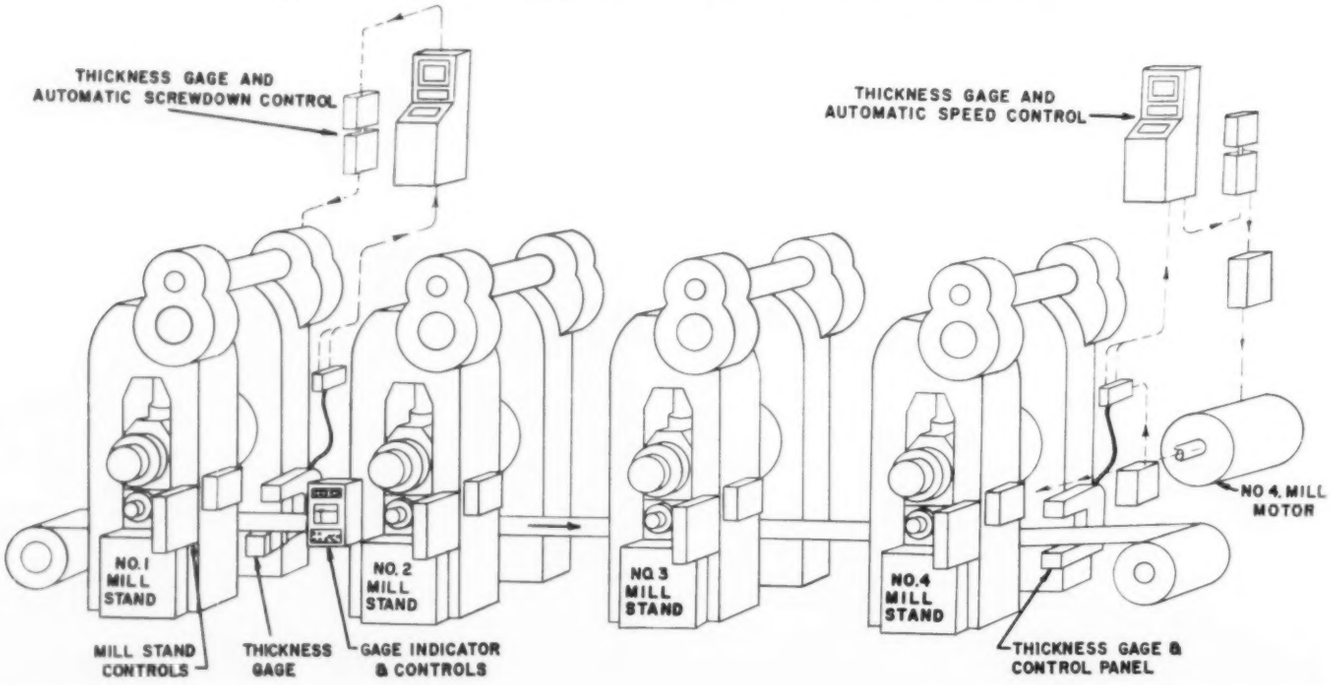
4. Screw-down adjustments on the first stand do not upset strip tension adjustments as severely as do screw-down adjustments on other mill stands.

The use of automatic screw-down control on this tandem mill resulted in a marked downward trend in the percentage of off-gage strip produced on this mill.

On a multiple stand cold strip mill, strip thickness control depends not only on screw-down adjustments but also on tension control between adjacent stands. Because of these factors, a second radioisotope thickness gage was installed on the fourth mill stand shortly after the installation of the screw-down control system described above. A controller circuit connected to this second gage served to regulate the speed of the last mill stand to automatically control finished strip thickness from this mill. This system is shown schematically in Figure 5.

A production analyzer study was made of the strip rolled using this screw-down–tension control system. Thickness data delivered from the gage to the production analyzer was divided into various tolerance groups. Simultaneously, a signal from a make and break contactor on the mill drive counted the length of strip in

Figure 5 — Schematic diagram shows control on screwdown and speed.


THICKNESS GAGE AND AUTOMATIC SCREWDOWN CONTROL
THICKNESS GAGE AND AUTOMATIC SPEED CONTROL
NO. 4 MILL MOTOR
NO. 1 MILL STAND
NO. 2 MILL STAND
NO. 3 MILL STAND
NO. 4 MILL STAND
MILL STAND CONTROLS
THICKNESS GAGE
GAGE INDICATOR & CONTROLS
THICKNESS GAGE & CONTROL PANEL

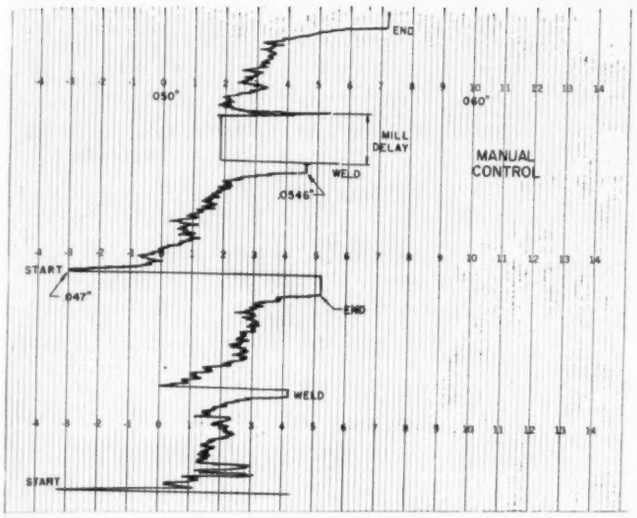


Figure 6 — Chart shows gage obtained when using manual control.

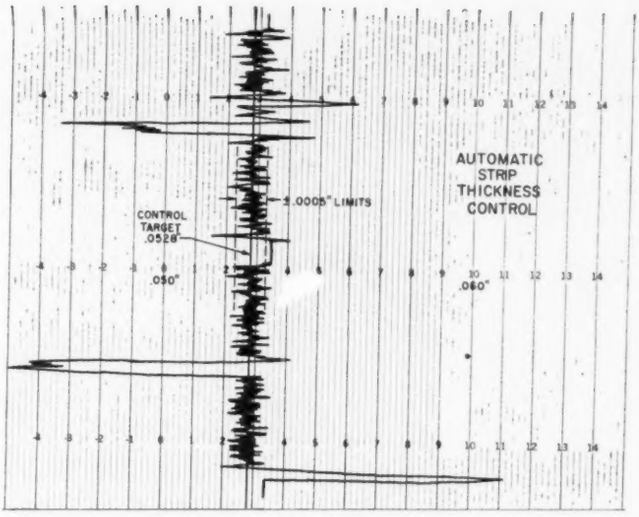


Figure 7 — Chart shows gage obtained when using automatic strip thickness control.

each tolerance group. This statistical study revealed that the screw-down-tension control system, compared to automatic screw-down control on the first stand only, produced improvements as high as 17 per cent in the quantity of strip held within ±0.0003 in.

This fourth stand speed control was a temporary field test setup. It was not made a permanent installation pending the installation of good tension indication on this mill.

The most effective use of a screw-down and tension control system for strip thickness control requires interlocking with accurate measurement of strip tension. Automatic thickness control action calling for strip thickness reduction at a time when the tension between two stands is already high will only lead to breaking the strip. Conversely, automatic thickness control action calling for an increase in strip thickness can result in a reduction of mill stand speed which will drop all tension between stands. This, in turn, results in loss of strip shape and rippled edges.

This need for an accurate and rugged tensiometer has led to the development, in the laboratory, of an instrument using strain gage load cells. This type of tensiometer gives a maximum of dependability with low maintenance. It is being provided for use with the automatic strip thickness control system for Niles and the new cold strip mills for Warren and Gadsden.

While the progress on automatic strip thickness control has been good, using the control systems described, there have been several shortcomings.

The speed of response of an automatic strip thickness control system, using the equipment in the conventional mill screwdowns, is governed by the time lag incurred in the electrical and mechanical linkages of the screwdowns. This time varies from one mill to another. Delay between a strip thickness variation signal at the thickness gage and motion of the mill screws and rolls resulting in a thickness correction can be as long as two seconds. This can represent the passage of 10 ft or more of off-gage strip before any corrective action is obtained. Ten feet of strip out of the first stand is at least 50 ft of tinplate at the last stand of the mill.

Another drawback of this system of control is the excessive wear incurred in the electrical switch gear which is activated much more frequently than under normal operator control of the mill screwdowns.

A still further drawback is the step function type of control obtained. A small correction is made on the mill screwdowns. It is followed by a pause during which time the thickness gage measures the resulting correction in strip thickness. If further correction is required after this pause, another step type correction is made. The length of time of each correction and pause is adjustable and is set to match the speed of operation of the mill screwdowns. Too much correction and too short a pause can lead to "hunting."

The process of "hunting" results when a corrective step results in overshooting of the control point. The overshoot then calls for a correction in the opposite direction. The new corrective action taken again results in an overshoot in the opposite direction. This process can become cumulative and will exaggerate instead of reduce the strip thickness variations.

Despite these shortcomings, the use of automatic controls has resulted in increased production of "on gage" strip. A production analyzer study on the Niles tandem mill showed 96 per cent of the strip held within 1 per cent of nominal thickness.

Figures 6 and 7, which are reproductions of the thick-

Figure 8 — It is obvious that automatic control reduces thickness variations markedly.

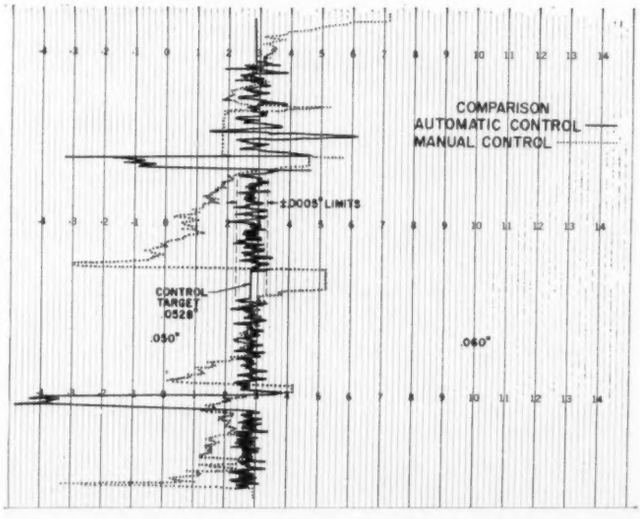


Figure 9 — In installing new equipment the first man who has to be satisfied is the mill operator.

ness gage recorder chart, show the results obtained using automatic strip thickness control.

Figure 6 shows the thickness variation of strip passing through the first stand with manual control on the mill screws. It is merely a reflection of the run down present in the hot band delivered to the cold strip mill, with a fixed percentage of cold mill reduction from front to back end.

Figure 7 shows the strip thickness control available using automatic strip thickness control.

On this chart, as in the others, the major scale graduations represent 0.001 in. The minor graduations represent 0.0002 in. The line marked "0" represents 0.050 in. The line marked "10" represents 0.060 in. There are 0.005 in. ranges on either end of the chart which overlap two other decade ranges of the thickness gage; hence, this chart represents a thickness range from 0.045 to 0.065 in., with 0.0528 in. as the automatic control target.

Figure 8 superimposes Figure 7 on Figure 6 and shows dramatically the comparison between manual control and automatic strip thickness control.

The results obtained with the use of automatic strip thickness control have been favorably received by all in Republic.

Even though Figure 9 shows the mill operator, those who have had to install newly developed equipment will appreciate the fact that selling a new idea to the operator is often no small part of the problem. The idea has been enthusiastically received by many others. The result is that automatic control is being incorporated in most of the mills currently under construction by Republic. They will be the latest steps in Republic's continuous effort to achieve automatic strip thickness control.

Discussion

PRESENTED BY

J. A. B. PINNEY, Electrical Engineer, Alan Wood Steel Co., Conshohocken, Pa.

R. A. PHILLIPS, Application Engineer, General Electric Co., Schenectady, N. Y.

C. E. PRITCHARD, Superintendent of Mills, Alan Wood Steel Co., Conshohocken, Pa.

HUGH S. MAXWELL, Steel Mill Application Engineer, General Electric Co., Schenectady, N. Y.

I. G. ORELLANA, Project Engineer, Electrical Laboratory, Republic Steel Corp., Cleveland, Ohio

J. A. B. Pinney: We from Alan Wood were particularly interested in hearing this paper, since we plan to start one of these units soon, to control the strip gage on our new 4-stand tandem mill. This installation is the result of a rather lengthy study that was made to determine whether or not we could justify the cost of the automatic gage control. We visited several plants and tried to determine just how they justified the installation of the automatic gage equipment. Naturally, every one of them had to say that they did it from the experimental standpoint. In other words, they could not at that time say that they expected so much return for their investment; or at least, they were not in a position to give us their economic justification for it. They said it would do a good job; it would do, as was mentioned, as good a job as the best roller, doing his best job, all the time.

So, we were faced with quite a problem, to try to determine how we could justify this expenditure to allow us to purchase gage equipment and so we had to approach from the reduced scrap loss and increased per cent on gage material angle.

Our production department and our industrial engineering department worked together to develop the expected savings along the lines mentioned above and came up with a favorable result.

R. A. Phillips: Mr. Orellana has presented a very interesting paper and those of us who have been in the business of designing and improving automatic gage control systems for quite some time are interested in this sort of approach I am sure.

In his early remarks Mr. Orellana mentioned only briefly the problem of the hot strip mill gage control which we have begun to give more and more thought to, and I had hoped that we would perhaps say a little more on that subject.

However, on the subject of cold mill gage control one thing we have found very important in the running of the control on the last stand of the tandem mill is that the time constant of the noncontacting radiation gage would be very short. I wonder if they have found the time constant of the gage they use has been any limitation to that operation.

C. E. Pritchard: You did comment, very briefly, about the problems associated with welds and it was indicated that there was generally quite a deviation at the weld area. It is known that this problem can and does put the onus of responsibility on the pickle line operations for getting better welds. This fact coupled with lack of experience on the part of the mill operators

during the early stages of putting these contacts into service operation have been found to be conducive to breaking of welds. I would like to have you elaborate on that phase a little more.

There have been several questions arise concerning the possibility of an attendant personnel hazard which might be encountered due to mill wrecks. I would like to have you elaborate on the range of possibility involved therewith and what has been done to accommodate same.

The mention of any new or different type tension control always brings up the proverbial question of how and to what extent its functional action is associated with the problem of stickers. Has it resulted in a measurable decrease in the number of sticker problems by virtue of the more finite tension control provided?

Mention was made of the frequency of the operation on the screw-down control mechanism, especially the electrical contacts. I was wondering if you would comment on the type of preventive maintenance program which you adapted to meet this situation. Have you made any design changes to circumvent or minimize this adverse condition?

Hugh S. Maxwell: I would like to emphasize the importance of the point Mr. Phillips mentioned, that is, the extremely short time constant of the radiation gage. I am not sure that it is possible for the isotope gage to have as short a time constant. Our 50-kv gage has a time constant of 0.1 sec. That is not so important on the gage after the first stand, but it is extremely important on the last stand.

We have three mills in operation, where you can watch the delivery gage controlling to ±0.0001 in. It is extremely important to have the system on the last stand arranged for forcing the field of the last stand motor.

I had hoped there would be more discussion of the speed of operation of screwdowns. Our first installation has constant potential screw-down control and the maintenance apparently has not been too bad, but there are definite advantages in having adjustable voltage.

Perhaps Mr. Orellana will also comment on the possible further advantage of having hydraulic control.

I. G. Orellana: I would like to start with Mr. Pritchard's and Mr. Pinney's questions on return on the investment.

The first automatic screw-down system, which we installed at Niles, was made as an experimental installation. In this case we knew ahead of time what we were going to obtain. The instrument manufacturer, whose gage we ultimately used, came into the mill and gave us a demonstration of the controls operating the mill. On this tandem mill, where we roll approximately 30,000 tons of tinplate per month, we have obtained approximately a 10 per cent increase of on-gage strip.

Following the installation of the automatic screw-down controls at Niles, the operators continued their old practice of slowing the mill for welds. To permit using the automatic controls without slowing down at welds requires that the welding equipment on the strip pickle line be given good maintenance and be properly adjusted. I do not know the exact percentage of weld failures on this mill. I have seen them roll welds without slowing down the mill and without experiencing any difficulty due to split welds. At other times, they definitely have to slow the mill down to roll the welds. Good welds can be obtained but it requires good welding practice in equipment properly maintained. The results are a reduction of production time lost because of having to clear out mill wrecks caused by split welds.

The radiation hazard present when using x-ray or radioisotope thickness gages is not readily apparent and has to be kept to a minimum. Any radiation thickness gage which we install has to be surveyed for stray radiation. It must meet our standards of safety which are based on the American Standards Association safety values for radiation. Our insistence on safety equipment has resulted in our x-ray and radioisotope thickness gages being built with negligible stray radiation.

To supplement the tests which we make with our own radiation detecting equipment, we have a qualified radiation physicist make an independent survey. He submits a report which is then available to anybody in the mill who raises any question about safety. It also gives the safety department a certificate saying we have a safe piece of equipment.

We do not attempt to play down the radiation hazard. We realize that there is a safety hazard if the equipment is not properly handled. We make all efforts to see that the equipment is properly designed, installed and maintained.

As a further safeguard, each of our radiation gage installations has been interlocked with mill operations. The radiation gages withdraw from the mill pass line when the mill stops, when the mills are at threading speed or if the strip should break. In each case the radiation gages must be brought back into operating positions and turned on by the operator.

On our hot strip mill installations, we have provided heavy structural guards for the radiation thickness gages. These guards are independent of the thickness gage and are capable of withstanding a direct blow from the strip. We have not had a radiation gage damaged by being hit by cobbling strip.

Mr. Phillips and Mr. Maxwell asked the question about thickness gage time-constants. I would like to explain that the "time-constant" of a thickness gage is the time elapsed between a variation in strip thickness and the time that the thickness gage shows approximately 63 per cent of this variation on its indicator. This "time-constant" of a thickness gage is an important factor in automatic controls.

The nature of the detector circuit used with an x-ray thickness gage makes for a short time constant. On a radioisotope thickness gage the detecting element, an ionization chamber, because of its structure, has a longer time constant. However, our experience using a radioisotope thickness gage has shown that this time constant is short enough that strip thickness information from the gage can be transmitted back through the screwdowns to control the strip thickness without accentuating the hunting which I mentioned previously. Our experience indicates that the automatic screw-down controls strip thickness better at fast mill speeds than at low mill speeds. At the lower mill speeds, the time constant is short enough that the information from the thickness gage gets back to the screws to change the thickness of the strip at a faster rate than the corrected strip goes from the mill rolls to the thickness gage.

If we could get a thickness gage which could be lo-

cated adjacent the mill rolls, the time constant of the thickness gage would have to be as short as possible. Locating a thickness gage thus is practically an impossibility on most mills. We have not found the time constant of the thickness gage a determining factor on our automatic screw-down controls.

With automatic screw-down controls the contactors on the mill screwdowns are operated repeatedly. Most of the mills in use, at least the older mills, have the contactor type of screw-down control. The contactor maintenance is in proportion to the age of the contactors and on the amount of run-down present in the hot-bands which the cold mills are called on to correct. If the hot-bands delivered to the cold strip mill have a small amount of thickness variation, the cold strip mill automatic screwdowns will do a much better job with a minimum of wear and tear on the screwdowns.

The problem of hot strip mill control is one that has been given considerable discussion at Republic. We have several ideas but have not as yet tried any of them. They are all based on the experience we have obtained from cold mill control.

To answer Mr. Pritchard's question on speed of response of mill screwdowns, I would say that it depends on the type of screw-down motor control available. Some of the newer mills are equipped with rotating regulator type control. The majority are equipped with contactor control. On those mills equipped with contactor control, there is a time lag between the thickness signal and the response of the screw-down motor. This time lag consists of the closing time of the contactors, the release of the motor brakes, the accelerating of the screw-down motors, the take-up of the slack in the gearing and, finally, the action of the mill roll. This time lag can be considerable. We know that as long as a second elapses between contact closing and the start up of the screw-down motors, another second elapses before the action results in an adjustment of the mill rolls. On the Niles mill where strip moves through the first stand at 240 fpm, these two seconds of lag represent eight feet of strip which have moved through the mill with no corrective action taking place. If the strip varied rapidly in thickness from point to point, this would be a serious problem. Normally, strip does not vary quite that badly, unless it has been badly rolled in the hot mill. With those mills, which are equipped with the newer rotating regulator type control, where the motors are constantly alive, the time lost between the arrival of the thickness signal and roll adjustment is considerably reduced.

Hydraulic control, which Mr. Maxwell mentioned, is currently in the experimental stage. Information on this control, we hope, will be submitted later through a paper such as this one. We know from our work with it that hydraulic control is much faster than any other type of screw-down control. It can also be adjusted to other variables occurring in the mill much more readily than electrical controls. ▲

1958

AISE Convention and Exposition

CLEVELAND PUBLIC AUDITORIUM

CLEVELAND, OHIO

SEPTEMBER 23, 24, 25, 26

CHOOSING THE RIGHT FASTENER

by WILLIAM P. ACRES
Assistant to General Manager
Bethlehem Steel Co.
Lebanon Plant
Lebanon, Pa.

In the past few years there have been extensive developments in various type fasteners . . . the mine bolt and structural bolt are coming applications.

THE industrial fastener field divides itself somewhat naturally into two broad classifications—special fasteners and standard fasteners. Special fasteners are those that must be individually designed, completely or in part, to meet unusual conditions. Generally speaking, their cost comes high due to tool charges and setup cost. Where short runs are involved, as is often the case, the actual cost of manufacture may be only a small part of the total. In some instances the die must be cast in favor of a specially designed fastener and with these we can find no fault. Then there are the many instances where a standard fastener is unquestionably the proper choice. There are also those occasions where, through lack of a thorough working knowledge of the standard fasteners available, specials are designed and made up, at considerable sacrifice in time and economy, to do a job that could have been done as well, if not better, by a readily obtainable, quantity produced, standard item.

Viewed in this light, it would seem obvious that, once the performance requirements and dimensional limitations for a given fastener application have been determined, ability to choose the right fastener must be predicated on a detailed knowledge of the vast array of standard fasteners available; and at this point it might be well to take a look at at least part of them. They cover a lot of territory—all the way from the common "square and square" found on every hardware store shelf to the meticulously engineered high-strength structural bolt with its semi-finished nut and hardened washers designed for use in the structural connections of today's skyscrapers and bridges.

As in the case of industrial fasteners as a whole, standard fasteners may be roughly separated into two classifications—general-purpose fasteners and fasteners engineered to meet specialized requirements.

In the first classification, general-purpose fasteners, we find the square and hexagon head bolt family:

Square head bolts—regular *only*. (The heavy head in the square variety is no longer with us.)
Regular and heavy hexagon head bolts.
Regular and heavy semi-finished hexagon head bolts.
Finished and heavy finished hexagon head bolts.
Cap screws—bright and heat-treated (very versatile items).
Lag bolts (do not forget they can be used in masonry when provided with an expansion shield).

In this same classification we also find the square and hexagon nut family:

Regular and heavy square nuts.
Finished hexagon and hexagon jam nuts.
Finished hexagon slotted, thick and thick slotted nuts.
Finished hexagon castle nuts.
(The "regular" hexagon nut series is on the way out and is being replaced by the "finished" hexagon series).
Machine screw and stove bolt nuts.
Heavy hexagon and hexagon jam nuts.
Heavy semi-finished hexagon and hexagon jam nuts.
Heavy semi-finished hexagon slotted nuts.

As the size ranges for these several series of bolts and nuts vary, they should be checked by reference to ASA Standard B18.2, latest edition, but, taking the bolts as a class, the size range covers from $\frac{1}{4}$ to 3 in. and the nuts similarly, from $\frac{1}{4}$ to 4 in., with the exception of machine screw and stove bolt nuts, where the upper limit is $\frac{3}{8}$ in. and the lower limit No. 0.

In addition to the square and hexagon head bolts we

also have the round head variety with the round head, square neck carriage bolt as the best known item, but the other members of this same group, which is covered by ASA Standard B18.5, must not be lost sight of. These include ribbed neck, fin neck and countersunk head, square neck carriage bolts, the button head bolt, two styles of elevator bolts, the step bolt, the counter sunk head bolt and, a sort of half-brother to the others, the T-head bolt.

If the assembly will never be taken apart after it has been put together, do not overlook the choice available in standard, general-purpose rivets. They are easy to come by and, in general, inexpensive to use. In the small varieties we find flat head, countersunk head, button head, pan head and truss head rivets, as detailed in ASA Standard B18.1. In sizes ½ in. and larger up to 1¾ in., we have the choice of button head, high button head, cone head, flat top, countersunk head, round top, countersunk head and pan head rivets as covered by ASA Standard B18.4.

The foregoing is by no means intended as a complete listing of standard general-purpose fasteners, but only as an indication of the extent of the coverage available. Nor should it be assumed that all can be supplied from stock.

In the second classification of standard fasteners, those engineered to meet specialized requirements, we have some that are precisely that and others which, to a greater or lesser extent, also belong to the general-purpose group, but for present purposes we shall include them here.

Among these specially engineered standard items we should perhaps include studs, although a considerable number of these actually belong to the general-purpose group:

Tap end, double end and continuous thread studs.
Carbon steel and carbon steel, heat-treated studs.
Alloy steel studs to ASTM Spec. A193 for high-temperature service.

In this second classification we also find carbon and alloy steel nuts for high-pressure and high-temperature service, as covered by ASTM Spec. A194. Of these, Grades 2 and 2H deserve special mention as their use is by no means limited to high-temperature applications. They are star performers in any service requiring a more rugged nut that will stand up under real punishment. They are more readily available in the heavy series, and it should be noted that, while in sizes 1 in. and smaller their tapping conforms to the coarse thread series, above 1 in. they are tapped 8 threads per in.

Specially engineered standard fasteners for railroad use include track bolts and nuts, with the commonly used varieties and sizes available from stock. These include in the smaller sizes, untreated bolts for mine and industrial trackage and, in the larger sizes, both untreated and heat-treated track bolts together with track bolt nuts, for standard gage trackage, as detailed in ASA Standard B18.10.

Mention should also be made of standard plow bolts, ASA Standard B18.9. Their use is by no means limited to agricultural implements for which they were designed and they should not be overlooked where flush heads are required for other applications.

The high-strength structural bolt is a specially designed standard fastener that should be given special attention for use in many fields. It has a great deal to recommend it, predominantly in structural work for which it was developed, but also for other applications where conditions require a rugged fastener with the ability to stay tight even under the most trying circumstances. This bolt, with regular semi-finished hexagon head, heavy semifinished hexagon nut and hardened washers, as covered dimensionally by the Research Council's Specification for Assembly of Structural Joints Using High-Strength Steel Bolts, and with its chemical and mechanical requirements carefully detailed in ASTM Spec. A-325, has a number of unique advantages over rivets and other fasteners in common use, and these we shall review briefly.

It virtually eliminates the need for fitting-up bolts which must be removed, few crews are required for its installation, yet the steelwork goes up fast at relatively low cost. New men can be trained quickly to handle the impact wrenches with which it is ordinarily tightened or tightening can be accomplished with a spanner if more convenient and, as it requires no heating equipment for installation there is no fire hazard. Once tightened, the high-strength bolt stays tight indefinitely, it offers 50 per cent better shear strength than a standard structural rivet, and its uniformly controllable greater clamping force, which is constant for all grips, increases the fatigue strength of the joint and eliminates or at least greatly reduces the ordinarily high concentration of stress around the holes. Besides all this, it is a standard stock item in ½ to 1¼-in. diam and all commonly called-for lengths.

In addition to a thoroughgoing acquaintance with the vast array of standard items we have today, ability to choose the right fastener for the job presupposes further knowledge which is not necessarily obtainable from the several published dimensional standards and material specifications, as all standard items are not necessarily equally available in all sizes, lengths or other particulars, and certainly all are not available from stock. The necessary detailed information as to what sizes, lengths or other particulars are applicable to what standard fasteners, without inadvertently transforming them into special products, can be acquired and kept current, however, by study of the fastener manufacturers' catalogs and other published data, supplemented by direct inquiry as to what standard product can be offered by the maker to properly meet a given set of conditions.

Referring more specifically to the manufacturer's place in the scheme of things, we might point out that, even with seemingly adequate fastener knowledge at hand, specials are being used in many potentially good standard-fastener applications with unnecessary added expense. Furthermore, many specials, where required, are costing more than they should, for no better reason than that it had not occurred to the user to take the manufacturer into his confidence concerning the basic end-use requirements of the item, thereby permitting him to serve in a consulting capacity in the choice of the fastener rather than merely to manufacture it.

This choice, however, should not be postponed, as too often is the case, until after all other design elements of the connection have been completed. Rather the fasteners to be used should be a matter of prime concern in the early stages of the design work, as generally at this

point only, is the designer free to make his choice—the right choice, with ability to perform as required and true over-all economy as his sole consideration.

Discussion

PRESENTED BY

WILLIAM P. ACRES, Assistant to General Manager, Lebanon Plant, Bethlehem Steel Co., Lebanon, Pa.

Member: Will you elaborate on the usage of high-strength structural bolts and mine roof bolts?

William P. Acres: It was not my intention to go into detail on any one of the fasteners, but, rather to accent the necessity of having sufficient knowledge of all standard fasteners, so that you could properly choose that which is most economic and that which will do the job best. However, I am glad of the opportunity of going into the matter of the high-strength structural bolt a little further, and also the mine roof bolt.

The high-strength structural bolt is relatively recent in its development from the standpoint of actual standardization of the assembly itself, the installation as well as the results obtained. The high-strength structural bolt is built around one concept, and that is that of clamping power It is based on the concept that if you could put a joint together with a strong enough spring holding it, so that instead of holding by the shear of a pin or rivet in the joint, you will be holding by the friction of the surfaces being clamped together. This was the subject of a good many years of research.

You still stay generally within the elastic limit of the steel in the bolt, and hold the two or the multiple surfaces together, with sufficient pull that the stress or the load that is imposed on the joint does not move those surfaces relative to each other. They stay in place, and the transmittal of stress from one to the other section of the joint is by virtue of friction between them, rather than by virtue of shear on the rivet.

The bolt, itself, is a medium carbon, heat-treated bolt with a semi-finished nut and with two either quenched and drawn or case hardened washers, one on the head of the bolt and the other on the nut. Where you have a beam and the bolts are in the flange of the beam, and you have an angle of either 12⅔ per cent or 5 per cent slope of angle to the flange, the washers are provided with the same slope—beveled washers.

These assemblies were first tried out in railroad bridges which were subject to a great deal of loosening of joints at critical points due to vibration, and to date the bolts that have been put in place, replacing rivets that became loose by vibration, have as yet to show up any loosening over a period of about five years.

This matter of holding by friction rather than by shear, as on the rivet, has another advantage in that you have a washer on either side of your assembly. The concentration of stresses, which is ordinarily associated with the hole, are deployed around the hole, by virtue of the fact that you have a larger area which is stressed, rather than a closely defined area. The business of staying tight has another effect to it which may not have been anticipated, and that is behavior as a lock nut that really locks and compensates for a loss of clamping power over a period of time.

Actually, what you are doing with the high-strength bolt when you tighten it up is to stretch the bolt so that it has within itself the inherent ability to make up for temperature differentials, and other elements that may tend to loosen the joint.

As far as the actual details of the bolt are concerned and the nut and the washers, they are covered by Research Council's standards and the ASTM specifications A-325.

It is a wonderful thing for many applications; other than buildings and bridges, such as machinery, vibrating screens or anything where you have the tendency of the joint to become loose, because you are holding, as it were, with a spring.

Now, the other item is the mine roof bolt.

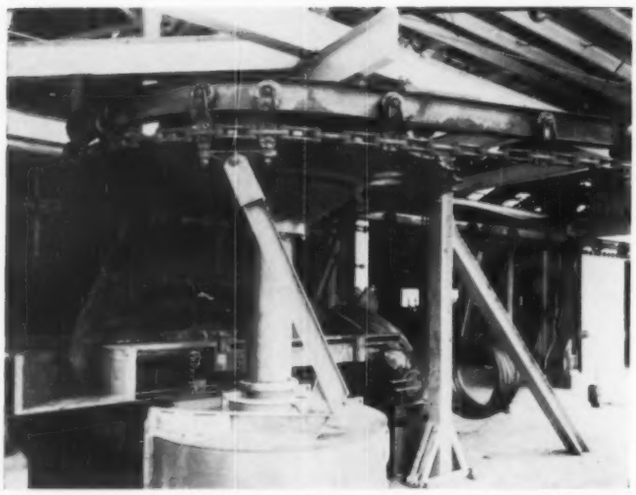
The mine bolt is a very old development. It has been with us for years and years, and for some reason or other, I guess about the only people that used it were the lead mines. Nobody else bothered about it. It did not seem to take, but of recent years it has developed from a fastener which was used occasionally, only, to a fastener which is used widely. It has gone from a matter of pieces, to a matter of thousands of tons a year.

It is a peculiar fastener in that it could be likened to a "sky-hook" or to pulling yourself up by your bootstraps. The old business of shoring up with timbers in a mine was successful to a certain extent, and also leaving pillars here and there at rather close intervals to maintain the roof, but those methods had certain disadvantages. One was, lack of economy, because you left a good deal of the stuff you were supposed to be mining out, in order to support your structure, so that your tunnels would be safe to work in. Then, again, there was the matter of ventilation; the shoring in the mine impeded ventilation tremendously. Then the fire hazard, due to using timber, was always a drawback.

Someone conceived the idea that if the strata that the roof of your mine is made of were held together as a beam, one could eliminate or at least greatly reduce the timbering. The mine roof bolt was the answer to that, and all it is is a bolt with a head on one end and a thread on the other, with an expansion shell or shield that has a tapered plug, threaded, with leaves on the shield. There are a number of different designs. Whereas the shield is screwed on the end of the bolt; the hole is drilled in the roof of the mine; the bolt with the shield on and the plug is pushed up into it, and the bolt is tightened, thereby pulling the tapered plug down into the expansion shell and anchoring it there. That is the first step.

The second step is torquing your bolt to a point where you are actually compressing the layers of overlying strata in the mine to a point where they become a solid beam. If you take a half dozen layers of clear plastic or something that can be bent, and bend them at the ends, the resistance to bending is reduced since they can move relative to each other. However, if at several points along those half dozen layers you put a bolt through them and then bend it, you have the equivalent, or close to the equivalent, of a solid beam, and that is the principle behind the mine roof bolts.

They are made in varying lengths, depending upon what is required of them, and they have worked out successfully, both in the prevention of the roof falls; the economy in the mine itself by making available additional material to be mined; by increasing the ease of ventilation, and by reducing the likelihood of a fire due to combustible wooden shoring. ▲



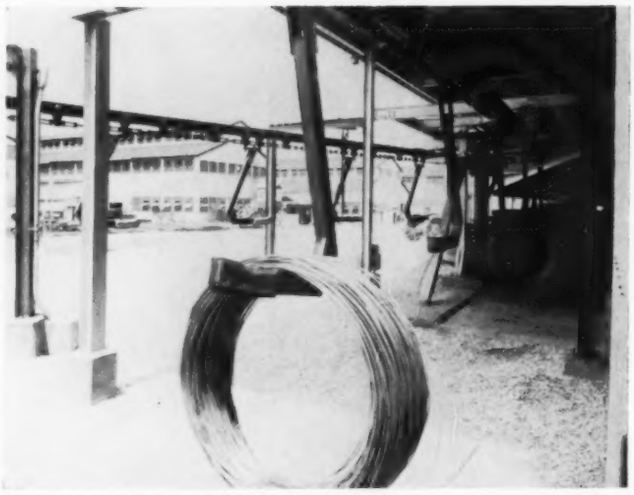


Figure 1 (left) — Automatic loading of the trolley conveyor is accomplished through synchronization of the conveyor with the chain conveyor which carries the coils from the mill. A rotating tilter flips up the coil at the end of the chain conveyor, permitting the carrier of the trolley conveyor to pick it up. Both conveyors have a common drive. Figure 2 (right) — The trolley conveyor picks up the coils (far right) and cradles them in a counterbalanced carrier which holds them securely. Corners of the hook are rounded.

Trolley Conveyor Handles Rod at Atlantic Steel

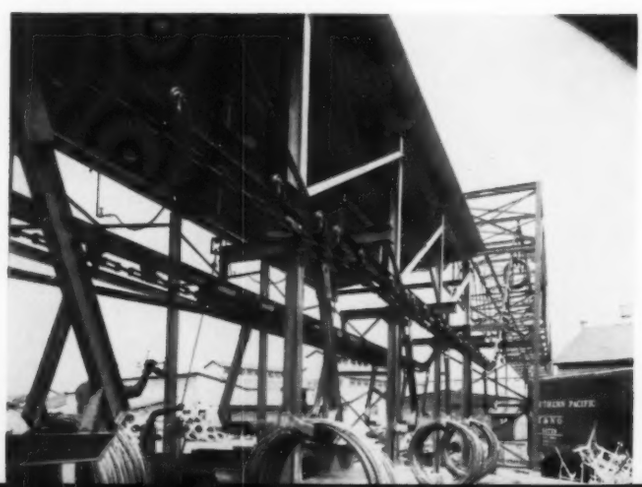
AN interesting feature of the new 21-stand merchant bar and rod mill recently put into operation by the Atlantic Steel Co. in Atlanta is the overhead trolley conveyor furnished by Link-Belt Co. This mill is one of the fastest and most modern combinations mills in the world.

The mill is a three-strand unit, finishing at speeds up to 5000 fpm, and rod is coiled automatically in 3000-ft long coils on three to six laying reels. The coils are then deposited on the chain conveyor which carries them out of the mill while they have a temperature at this point of about 1750 F. Coils are transferred automatically from the chain conveyor to a trolley conveyor. The two conveyors are synchronized through a common drive and the carrier of the trolley conveyor picks up the coil as it is flipped up by a rotating tilter at the end of the chain conveyor. The 600-lb coils, which have an outside diameter of about 46 in., are carried transversely, resting on heavy counterbalanced carriers suspended on two pairs of trolleys and spaced every eight feet. The temperature of the coils is 800 to 900 F when they are placed on the conveyor.

Since there is a considerable distance between the wire mill and the building where the new merchant bar and rod mill is located, and since a number of railroad tracks prevent a direct surface route for the coils, the design of the trolley conveyor was complicated. It was necessary to route the conveyor with a dogleg to go around structures in the direct path, and it was also necessary to elevate the coils for distances of 210 ft to pass over the tracks and two small buildings. The conveyor then returns to the previous elevation with the trolleys about eight feet above the ground as it nears the wire mill. The speed of the conveyor is from 20 to 60 fpm; it has a capacity of 150 to 450 carriers an hour. The conveyor also serves to cool the coils during transit.

The coils are removed by a hoist at the take-off station and delivered either directly to the wire mill or to a storage area outside the mill. There is also a second take-off station just east of the dogleg for storage of larger sizes of rod. ▲

Figure 3 (left) — The conveyor sweeps to a height of 34 ft in order to pass over six railroad tracks and two small buildings. The bridge section is about 210 ft long. Figure 4 (right) — The conveyor returns to ground level, and the coils are removed by hoist at the take-off station. They are moved directly into the wire mill or held in an adjacent storage area.

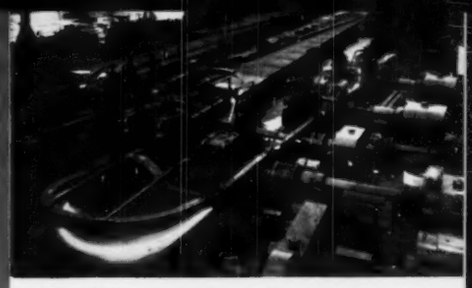


One of the world's fastest

BAR and ROD MILLS

4-way example of service to the Steel Industry by

The Rust Engineering Company and Subsidiary Companies



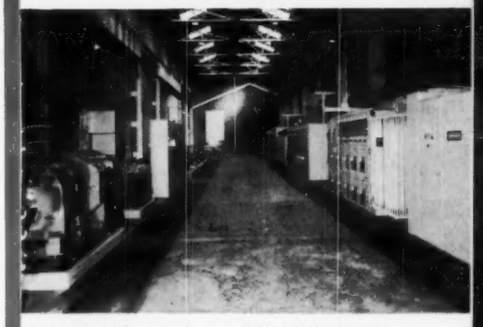
Rod Mill in operation. All machinery, equipment and utilities installed by Rust personnel.

21-Stand, 13" Combination Merchant Bar and Rod Mill Building, designed and constructed for ATLANTIC STEEL COMPANY, Atlanta, Ga.

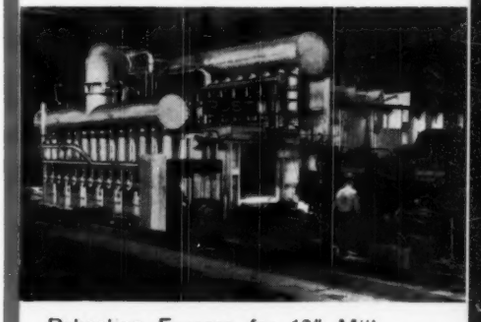
Helping Atlantic Steel Company fulfill its expansion plans for additional facilities to increase production, The Rust Engineering Company and Subsidiary Companies completed the following contracts, in providing this efficient new mill:

1. **DESIGN AND CONSTRUCTION** Building facilities for this combination merchant bar and rod mill were designed and constructed by The Rust Engineering Company The plant is completely new.
2. **MACHINERY INSTALLATION** All machinery, auxiliary equipment and utilities were installed by The Rust Engineering Company.
3. **ELECTRICAL INSTALLATION** Electrical work was handled by Allegheny Industrial Electrical Company, Inc.
4. **REHEATING FURNACE** The double-fired, zone controlled, recuperative, continuous reheating furnace was designed, built and installed by Rust Furnace Company.

This modern mill has a maximum speed of 5,000 feet per minute for rods, and a production rate of 50 to 70 tons per hour for merchant products. The mill produces rods, rounds, flats, angles, and light beams of various sizes.



Motor Room of new Mill. All electrical installations by Allegheny Industrial Electrical Co., Inc.



Reheating Furnace for 13" Mill — designed, built and installed by Rust Furnace Company.

THE RUST ENGINEERING COMPANY

and Subsidiary Companies

RUST FURNACE COMPANY • ALLEGHENY INDUSTRIAL ELECTRICAL COMPANY, INC.

930 FORT DUQUESNE BOULEVARD, PITTSBURGH 22, PA.

BIRMINGHAM BOSTON NEW YORK WASHINGTON

The Rust organization is ready to work with you on your next project, whether it is a large complete plant or a small modernizing alteration. Rust services to all industries include many specialties. Write for details!

RE-1

View through door of a press forge furnace showing B&W Insulating Firebrick walls and arches and B&W 80 Firebrick floor. The burners and flues are visible on the back wall.

B&W Insulating Firebrick reduce fuel costs 15% and increase production

Experience paid off for this major steel producer. Aware of the benefits of B&W Insulating Firebrick in his drop forge furnaces, he built two new press forge furnaces with lightweight B&W IFB linings. The results were a minimum average fuel saving of 15% *and* increased production, since the entire heating process for certain grades of steel could now be accomplished in one operation. Here's why.

The lightweight and consequent low heat storage of B&W IFB linings keep the furnace walls at a uniform temperature to provide the most efficient heating conditions. Unlike heavier constructions, B&W Insulating Firebrick linings attain a uniform temperature faster with less fuel consumption.

In addition, B&W IFB linings respond quicker to temperature changes, permitting more accurate temperature control. In this instance, this not only prevented the cracking of tool and stainless steels, but helped reduce the total heating cycle, increasing production.

These forging furnaces use a 9" B&W K-30 IFB wall backed up by B&W K-20 IFB. The K-30 is used as face brick because of its high temperature resistance. The K-20 is used as a backing because of its high insulating value. The hearth floor is of B&W 80 Firebrick for abrasion resistance and resistance against attack by mill-scale at the temperatures involved. Door linings are of B&W Kaocast and B&W Kaolite. R-583

B&W REFRACTORIES PRODUCTS: B&W Allmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick • B&W Insulating Firebrick • B&W Refractory Castables, Plastics, and Mortars • B&W Silicon Carbide • B&W Ramming Mixes

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

New Wrought Iron Developed by A. M. Byers Co.

Figure 1 — Iron is transported from cupolas to one of the plant's bessemer converters where it is further refined. After this process is completed, deoxidization of the metal is performed by adding a reducing agent to the ladle.

AN important development in wrought iron metallurgy—new 4-D wrought iron—was recently announced by A. M. Byers Co. Seventeen years of service and laboratory tests have been conducted to compare new 4-D wrought iron not only with standard wrought iron, but with a number of other metals. The results of these tests have proved that new 4-D wrought iron has superior resistance against many kinds of corrosive forces including those caused by severe industrial atmospheres, acid solutions, salt water and steam condensates.

The improved 4-D wrought iron was achieved by substantially increasing the deoxidation of the base metal; increasing the phosphorous content in relation to the other material components; and using a more siliceous silicate fiberous material. Approximately 250,000 of these silicate fibers are evenly distributed throughout each cross-sectional square inch of the metal.

Tests have also shown that new 4-D wrought iron has greater uniformity, plus improved physical and mechanical properties. The new 4-D (which is simply a marketing term used to distinguish from standard wrought iron) is now on the market, and will sell for the same price as standard wrought iron. ▲

Figure 2 — Highly refined iron is poured from the process ladle into molten slag forming a sponge ball in the ladle below. The process ladle oscillates during the pour so that the base metal will be evenly blended with the slag.

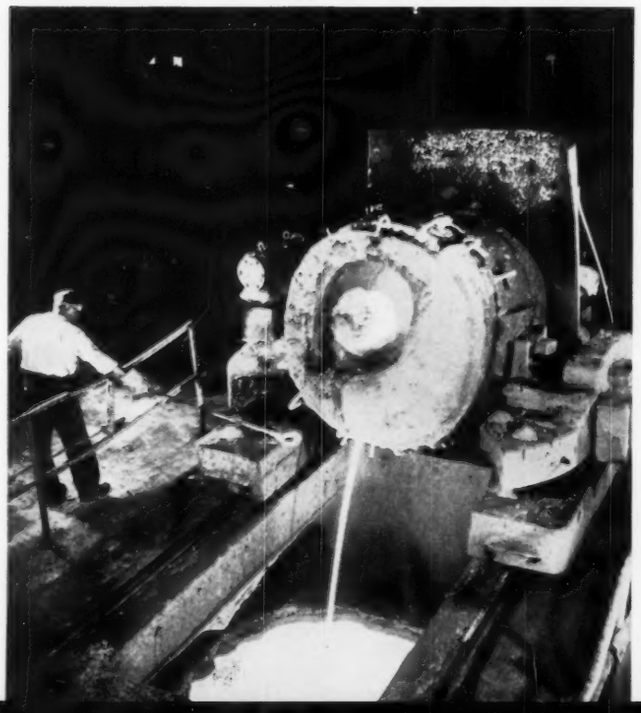
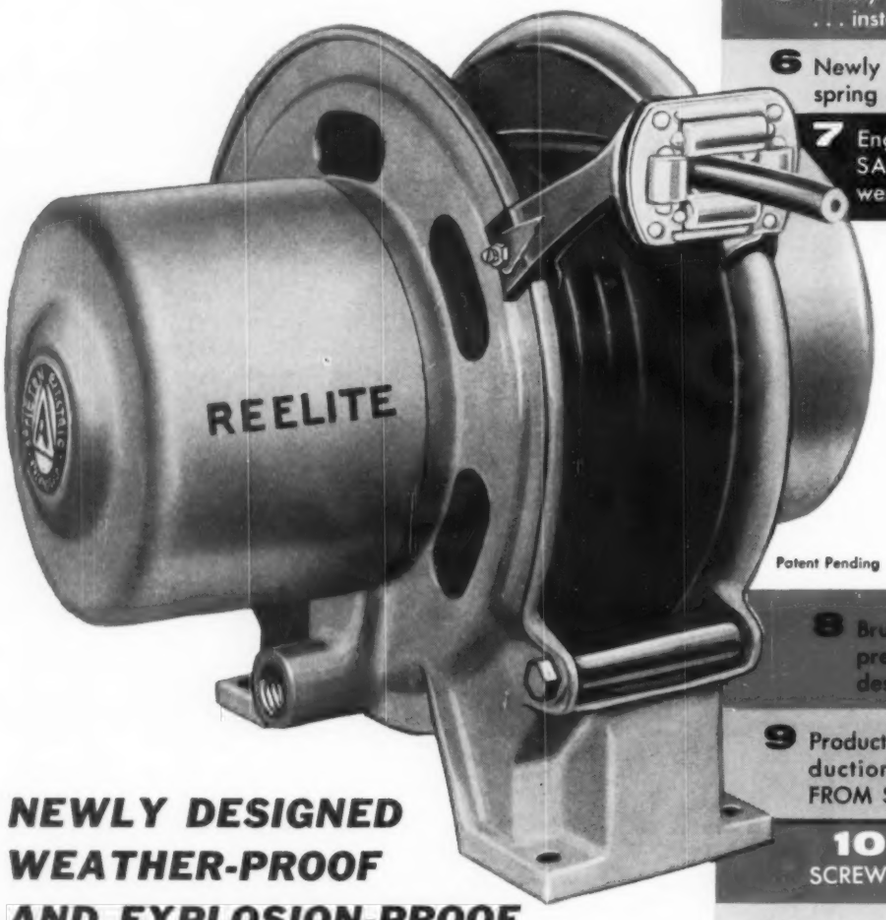


Figure 3 — The product is a wrought iron sponge ball, which here is being discharged from the ladle onto the bed of a forging press. The press will squeeze the ball into a bloom and send it along to the blooming mill.

NEW from APPLETON®



1 Available in both WEATHER-PROOF and EXPLOSION-PROOF series.

2 One-piece UNI-CAST main frame . . . assures perfect alignment . . . lightweight.

3 Snap-on or threaded covers . . . NO SCREWS . . . remain tightly sealed . . . release in seconds.

4 HOLLOW SHAFT construction . . . pressure type internal cable grip . . . fast cable replacement.

5 Safety SPRING CARTRIDGE . . . self-contained . . . instantly replaceable.

6 Newly designed SPRING MOTORS . . . finest spring steel . . . longer life.

7 Engineered for easy installation . . . SAFE MAINTENANCE . . . under all weather conditions.

Every feature you want is here! . . . 15 reasons why APPLETON'S new Reelite Series gives you safe, uninterrupted service with considerable maintenance savings

Patent Pending

8 Brushes with floating tension . . . uniform pressure . . . ARC-LESS contact on newly designed collector rings.

9 Production line economies . . . volume production savings . . . immediate DELIVERY FROM STOCK.

10 No special tools required . . . only a SCREW DRIVER needed for maintenance.

11 MULTIPLE CONDUCTOR units available . . . wide, dependable electrical contact surfaces.

12 Wide range of ACCESSORIES . . . custom installations.

13 Internal RATCHET available. Will prevent recoil of cable, when application requires it. Specify if desired.

14 Explosion-proof models have pre-wired explosion-proof chamber from collector rings to junction box . . . designed for HAZARDOUS AREAS.

15 Custom assembly . . . constructed by experienced REELITE technicians.

Write today for Bulletin 504, contains complete information.

NEWLY DESIGNED WEATHER-PROOF AND EXPLOSION-PROOF

REELITES

automatic cable take-up reels

THE STANDARD FOR BETTER REELS

APPLETON ELECTRIC COMPANY

1709 Wellington Avenue • Chicago 13, Illinois

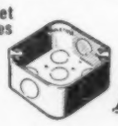
APPLETON ELECTRIC PRODUCTS®

Also Manufacturers of:

Malleable Iron Unilet Fittings

Explosion-Proof Fixtures

Outlet Boxes



Industrial Lighting Equipment

Good Engineering Gives Good Piping Layouts

ONE of the most spectacular examples of the dependence of huge automatic industrial machinery on fluid circulation systems for heat control, lubrication, lubricant temperature, and operating control is in steelmaking. The elaborate piping systems that are required to deliver to a modern sheet steel rolling mill the cooling water and special coolants, the various lubricants, hydraulic oil and air represent some of the best of engineering talent.

For one of the fastest and heaviest sheet mills in the steel industry, which can cold roll sheet steel at 40 mphr while reducing its thickness to one-third, Blaw-Knox Co.'s Power Piping and Sprinkler Division recently engineered and installed one of the most complex, compact, and accessible automatic piping systems. Everything but water is delivered to points of use from storage tanks in a 34 by 96-ft basement.

The basement installation does not include the water system for cooling mill rolls or the main part of a recirculating water system of 5000 gal capacity which includes piping in the oil storage tanks and to air coolers for drive motors in the motor room.

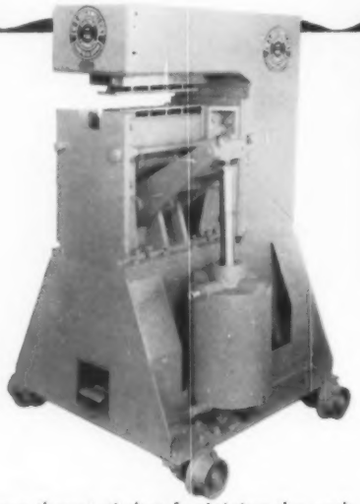
The principal machinery that depends upon these systems is a 77-in., four-stand, four-high, cold reducing mill which was completed recently for Jones & Laughlin Steel Corp. in its Cleveland Works at a cost of about $10,000,000. Nearly 23,000 hp, believed to be the highest in the steel industry for this type of mill, is available from ten electric motors that drive this mill.

The several systems that deliver lubricants and special roll coolant, that serve and operate the mill hydraulically and pneumatically are the most colorful in spite of being the least seen. System identification

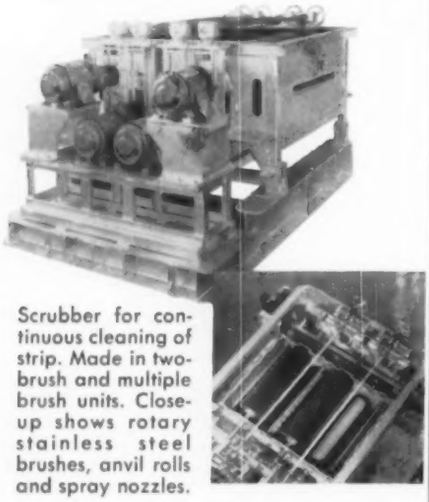
Figure 1 — This complex, compact, and accessible installation of piping systems for a sheet mill was engineered and installed to supply heat control, lubrication, and operating control. Bright colors distinguish each system.

Figure 2 — Air controls, coolant valves, and piping for the new 77-in., four-stand cold-rolling mill. The large overhead pipe carries water. Occasional inspection and adjustment keeps this equipment in working order.

Rockwell
AUXILIARY
EQUIPMENT for
Strip Mills



Open throat stitcher for joining the ends of two strip coils, ferrous or non-ferrous, where welding is not feasible and a positive joint is required.



Scrubber for continuous cleaning of strip. Made in two-brush and multiple brush units. Close-up shows rotary stainless steel brushes, anvil rolls and spray nozzles.

We manufacture coil boxes, coil winding machines, dryers, furnaces and other equipment to customers' drawings or completely Rockwell-engineered. Inquiries invited.

W. S. ROCKWELL COMPANY
2428 ELIOT STREET
FAIRFIELD, CONN.

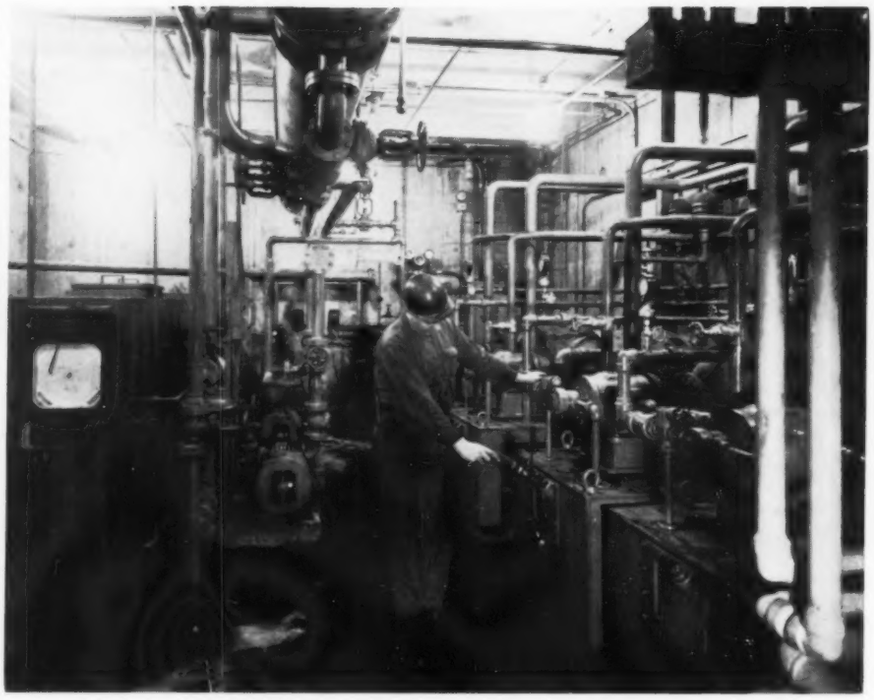


Figure 3 — Lubrication and coolant systems for a new temper mill in the Cleveland works of Jones & Laughlin Steel Corp.

requires the use of all colors of the rainbow plus black, gray, and aluminum to distinguish five lubricating oil systems, two pressure grease-systems, an oil emulsion coolant system, a 3500-psi hydraulic system for maintaining roll balance, a 1000-psi hydraulic system for operating 14 mill controls, a compressed air system for 18 mill controls, and a steam system for maintaining lubricating oil temperature when the mill is idle. All of these systems are fully automatic and require no attention except occasional adjustments to assure continuous, trouble-free operation.

Much of the basement space is taken by storage tanks which hold approximately 56,000 gal of various types of lubricants and cooling oil emulsion.

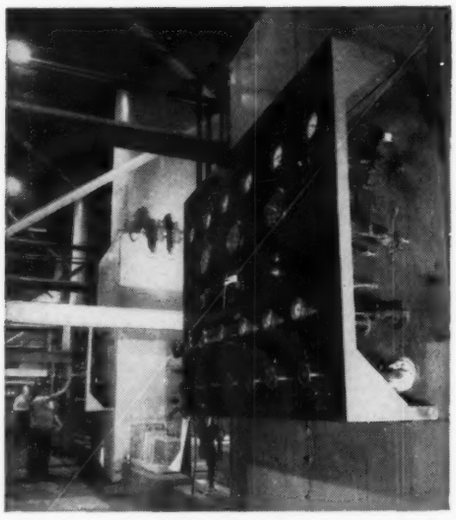
The water systems are also features of Blaw-Knox engineering in its Power Piping Division. It was found that the city water used to cool the several gas machines in bright annealing processes was clean enough for mill requirements. The outlets of these machines were, therefore, piped into a sump and then pumped to the 10,000-gal storage tank near the cold-rolling mill. This tank has an overflow to dispose of excess supply and an electric altitude valve to admit city water automatically if the supply from the gas machines become inadequate at any time.

One of the features of the cold rolling mill is a provision for using either of two roll coolants on the fourth stand, clear water or oil emulsion. On the first three stands only, oil emulsion is used for roll cooling. About 1000 gpm of water can be delivered to the rolls of the fourth stand. When this is done, the twice-used water then goes to the sewer.

The recirculating water that is used to cool the oil is pumped through several oil coolers in the basement area and through air-coolers in the motor room. From there it goes to a cooling tower from which it returns to the coolers. Circulation loss is less than 200 gphr which is made up from city mains. It is expected that these two systems will pay for themselves within a few months.

Similar but less elaborate piping systems were designed and insta by Blaw-Knox for J&L's new single stand temper mill. In addition the Power Piping Division designed and installed new water systems for the entire Cleveland Works for service and city water, including four pump houses. The largest of these contains two 16,000-gpm centrifugal pumps powered by 600-hp motors. Water for a new blooming mill is delivered by two 4000-gpm centrifugal pumps. ▲

Your Key to this Plant



an Eichleay "Turnkey" Installation

Air Products Inc.

Oxygen Plant

at

Jones & Laughlin Steel Corporation

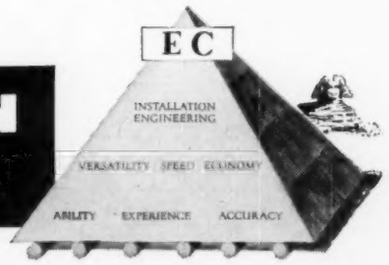
PITTSBURGH WORKS

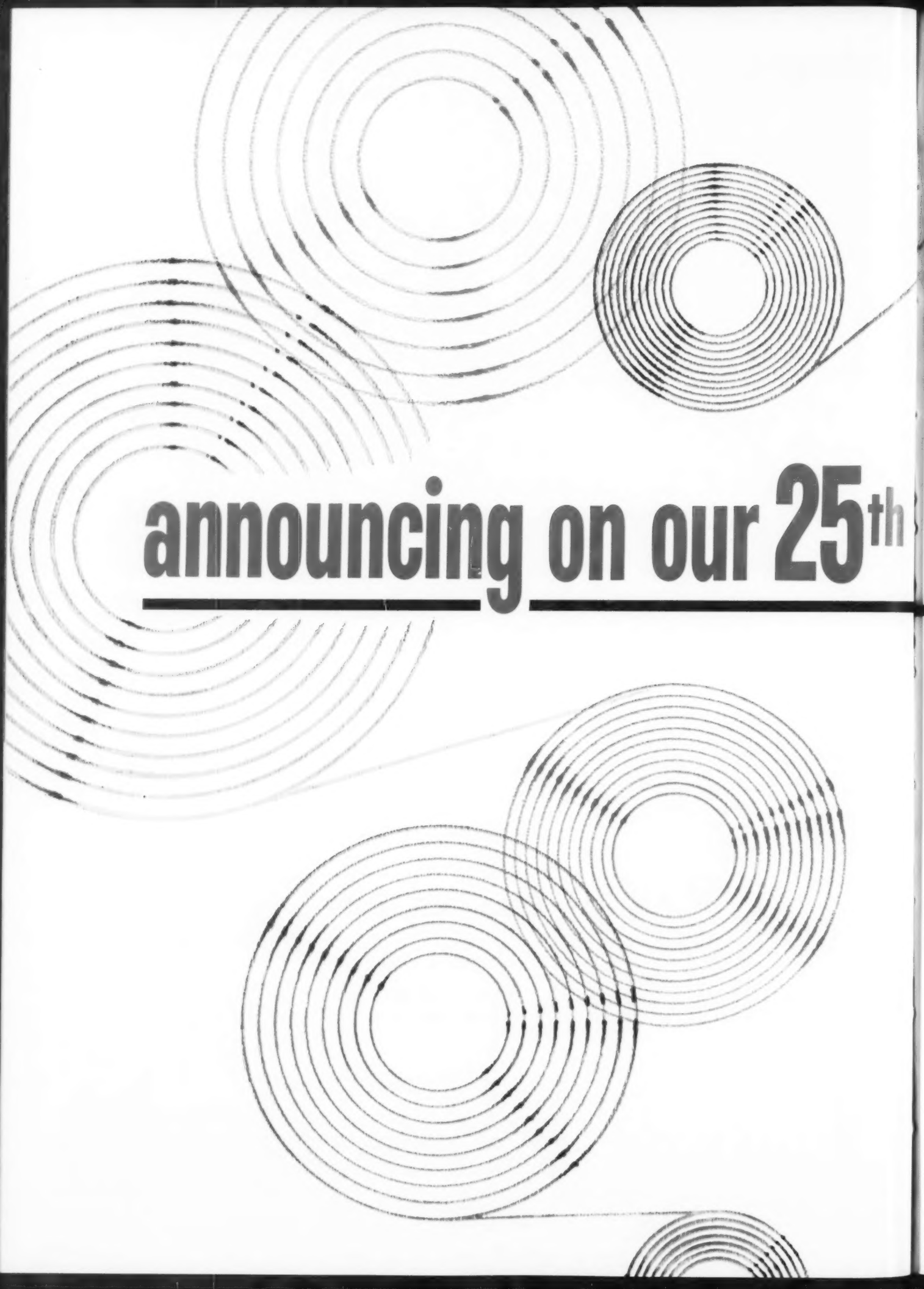
Eichleay

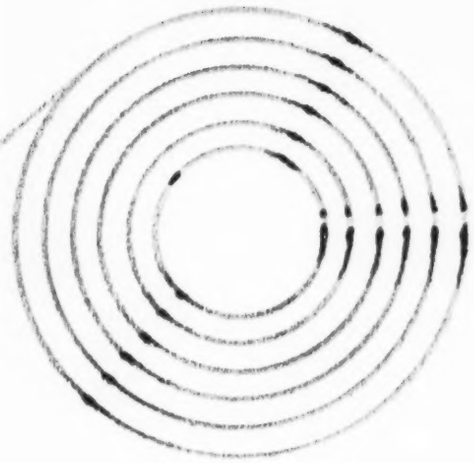
ESTABLISHED 1875

CORPORATION

33 South 19th St., Pittsburgh 3, Pa.
1180 Richard Ave., Santa Clara, Calif.




announcing on our 25th



th

anniversary

A REVOLUTIONARY NEW COIL ANNEALING SYSTEM

The Lee Wilson opened coil annealer

For the past quarter century the name Lee Wilson has been symbolic of annealing leadership. Now, on our 25th Anniversary, we are proud to announce the Lee Wilson Opened Coil System that is certain to become the standard of the industry.

The Lee Wilson Opened Coil System has all the advantages of continuous strand annealing with none of the disadvantages. It requires far less area and installation costs. It is easier to maintain. It anneals with a uniform thoroughness unmatched by any other method. It exposes 400 times more area to heating than conventional coil furnaces and delivers tonnages greater than modern day continuous furnaces. Its operating cost per ton is much less.

These are but a few of the outstanding features of this revolutionary new annealing system. We're sure you'll want to know more, so why not make a date to talk with a Lee Wilson engineer. When you get the facts, you'll be as excited about the Opened Coil System as we are.

Lee Wilson* ENGINEERING COMPANY, INC.

20005 WEST LAKE ROAD • CLEVELAND 16, OHIO

SINGLE-STACK RADIANT TUBE ANNEALING FURNACES

MAKE THE BEST METALS BETTER

* ORIGINATORS AND LEADING PRODUCERS OF SINGLE-STACK RADIANT TUBE FURNACES

2228

Figure 1 (left) — Work of adapting one of Pittsburgh Coke & Chemical Co.'s blast furnaces for the production of ferromanganese and spiegeleisen, as well as pig iron, has been completed. The four stoves were increased in capacity by 30 per cent.

Figure 2 (right) — Workman makes final check on the newly relined blast furnace. Pipes on the floor are designed for pre-injection of heated air for drying out the furnace.

Pittsburgh Coke & Chemical Co. Starts Ferromanganese Production

THE growing market for the strategic metal, ferromanganese, has a new supplier with Pittsburgh Coke & Chemical Co. who recently made its first production run from one of its Neville Island, Pa., blast furnaces.

The company will now be the second noncaptive blast furnace producer of ferromanganese in the United States. The new product of the company is necessary to the production of steel as a cleansing and alloying agent.

Adaptation of the firm's Blast Furnace "A" for the production of ferromanganese, in addition to pig iron, was accomplished at an approximate cost of $2,500,000. Half of this cost was for a specialized gas cleaning system for the prevention

Figure 3 — Molten ferromanganese will cool and harden in the gondola for a 24-hr period before it is unloaded into a crusher for storage or customer delivery. Ferromanganese is nonmagnetic, and is cast into refractory-lined gondola cars for handling and slow cooling.

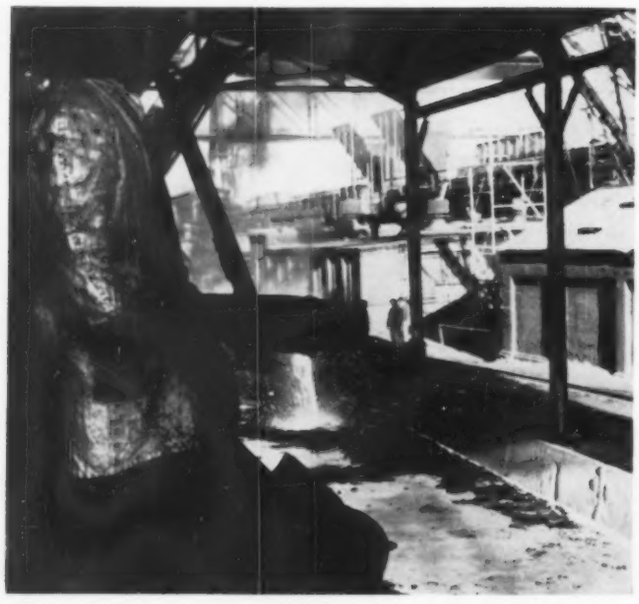
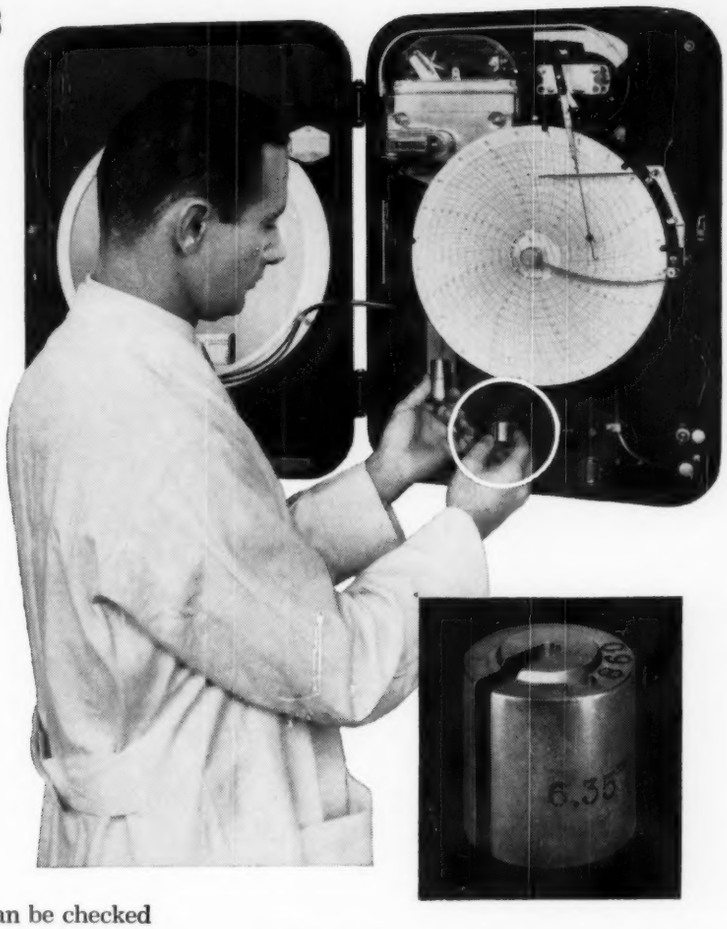


Figure 4 — A Grade-all, equipped with special teeth, rips at the hardened ferromanganese in the gondola car, before depositing it in a machine for crushing to a specified size.

HAGAN RING BALANCE FEATURES—NO. 3

CHECK CALIBRATION OR CHANGE RANGE IN MINUTES

without water columns—without disconnecting meter from line



TIME SAVER—This shows how easily a Ring Balance can be checked. Note there are no two-story water columns—one man is doing the job—and the meter has not been disconnected from the line. In fact, Ring Balance can be checked at full static pressure if desirable.

The check weight is factory calibrated against a micrometer type manometer, and its equivalent in inches of water column is stamped on the side. The serial number of the meter to which it belongs is also stamped on the collar. A full set of calibrated weights is supplied with each meter.

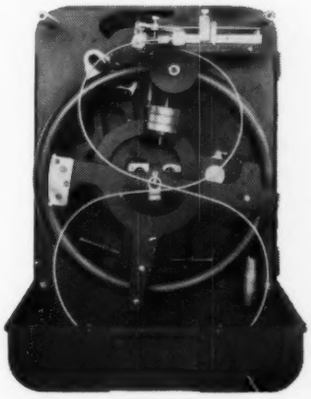
The calibration of any Hagan Ring Balance meter can be checked —in minutes—by simply hanging the appropriate weight on the check weight rod. Similarly, range change over a seven to one differential range can be done with equal speed and accuracy.

In terms of instrument technician's time, you can easily figure how much this one feature of the Ring Balance will save you. And, you don't have to take a busy pipefitter away from other work to break connections.

Ask your Hagan engineer to show you how easily range change and calibration checks can be made, using only the set of check weights supplied with each meter. Ask him, too, to explain some of these other outstanding features of the Hagan Ring Balance:

1. High sensitivity at low flows due to unique range calibration system. Full scale deflection at ½" WC.
2. Safe operation with rings rated at 2,500, 6,000, 15,000 psig. No gaskets, no stuffing boxes.
3. Sealing fluid density and level not critical. No eye-droppers.
4. Interchangeable ring assemblies for full scale ranges from 0.5" WC to 560" WC. Adjustment on any one ring over a seven to one differential range.
5. Wide range computation and/or compensation by means of built-in, easily checked mechanisms available on most models.
6. Pneumatic or electric transmission also available.

Bulletin MSP-141 describes these features and the new design of the Hagan Ring Balance meter case. ASK US FOR IT.



Rear view of Ring Balance with cover plates removed. Here the test weights are in position on the test weight rod. Note accessibility of all parts for easy adjustment.

HAGAN CHEMICALS & CONTROLS, INC.

HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY, HALL LABORATORIES
IN CANADA: HAGAN CORPORATION (CANADA) LIMITED, TORONTO

of air and stream pollution.

With some 15 lb of ferromanganese being consumed for every ton of steel produced, its volume of production is exceeded only by iron, aluminum and copper. Pittsburgh Coke's adapted furnace has a daily capacity of some 400 tons of ferromanganese, or more of spiegeleisen.

Capability of the furnace to produce ferromanganese and spiegeleisen, as well as pig iron, should result in greater productivity and more profitable utilization of the equipment, since ferromanganese sells for approximately $274 per ton as compared to about $66 per ton for pig iron.

Pittsburgh Coke's entry into the ferroalloys field had been studied extensively for some time, and was considered a natural move for the company. A new wholly owned subsidiary, Neville Ferro Alloy Co. will handle ferroalloys marketing to the steel industry.

Some of the details of Blast Furnace A are as follows:

Height	95 ft
Hearth diameter	22 ft
Tuyeres	12
Hot blast stoves	4 (with 435,000 sq ft of heating surface)
Height	100 ft
Diameter	22 ft

Furnace productive capacity

Pig iron	900 tons per day
Ferromanganese	400 tons per day
Spiegeleisen	600 tons per day

Gas Cleaning System

A specialized, completely enclosed wet gas scrubbing system, operating under high top pressure, designed and engineered by Pittsburgh Coke & Chemical Co. engineers (patent pending). Cleans gas to 0.01 gr of flue dust per cu ft, well below the maximum allowable level of 0.20 gr per cu ft specified in Allegheny County, Pa., ordinances.

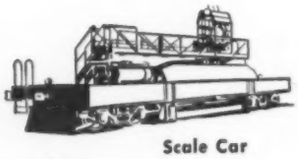
Basically, Pittsburgh Coke's system consists of a large dust catcher in which the larger particles are dropped out of the gas stream through the reduction of velocity and a change in the directional flow.

The gas which still contains about 10 gr of dust per cu ft, is forced through a specially designed wet venturi type gas fume scrubber built by the Chemical Construction Co. Jets of relatively low pressure water are sprayed into the throat restriction and the gas is forced through this film of atomized water at velocities between 200 to 400 fps. The 3½-psi pressure on top of the furnace is used to force the gas through the venturi restriction.

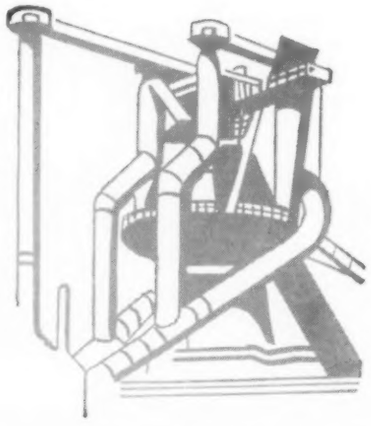
The scrubbing water containing the particles of dust and alkali cyanides flows to a settling and thickening basin. From here the water is recirculated back to the venturi gas scrubber. The solids which were settled out in the thickener are recharged to the furnaces or stored in our ore yard for future agglomeration. Thus the entire system is completely enclosed with the water being recirculated and a greater part of the fine dust being recharged to the furnace, the remainder being stored for future use.

The gas is used to underfire stoves and steam boilers. ▲

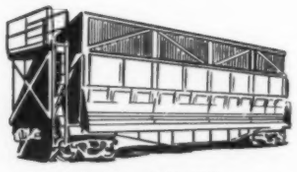
WHEREVER *performance* COUNTS



Scale Car



100-ton Ore Transfer Double Compartment, Bottom Dump



Coke Quenching Car

Atlas Cars are built to resist the high wear factors of continuous service handling abrasive materials. Extra factors of safety in brakes, controls, visibility, and signal devices are incorporated for foolproof service.

Each car is engineered to meet the operating needs of the plant where it will be used.

Consult Atlas for your Steel Plant Cars

ATLAS
CAR & MFG. CO.
1100 IVANHOE ROAD
CLEVELAND 10, OHIO

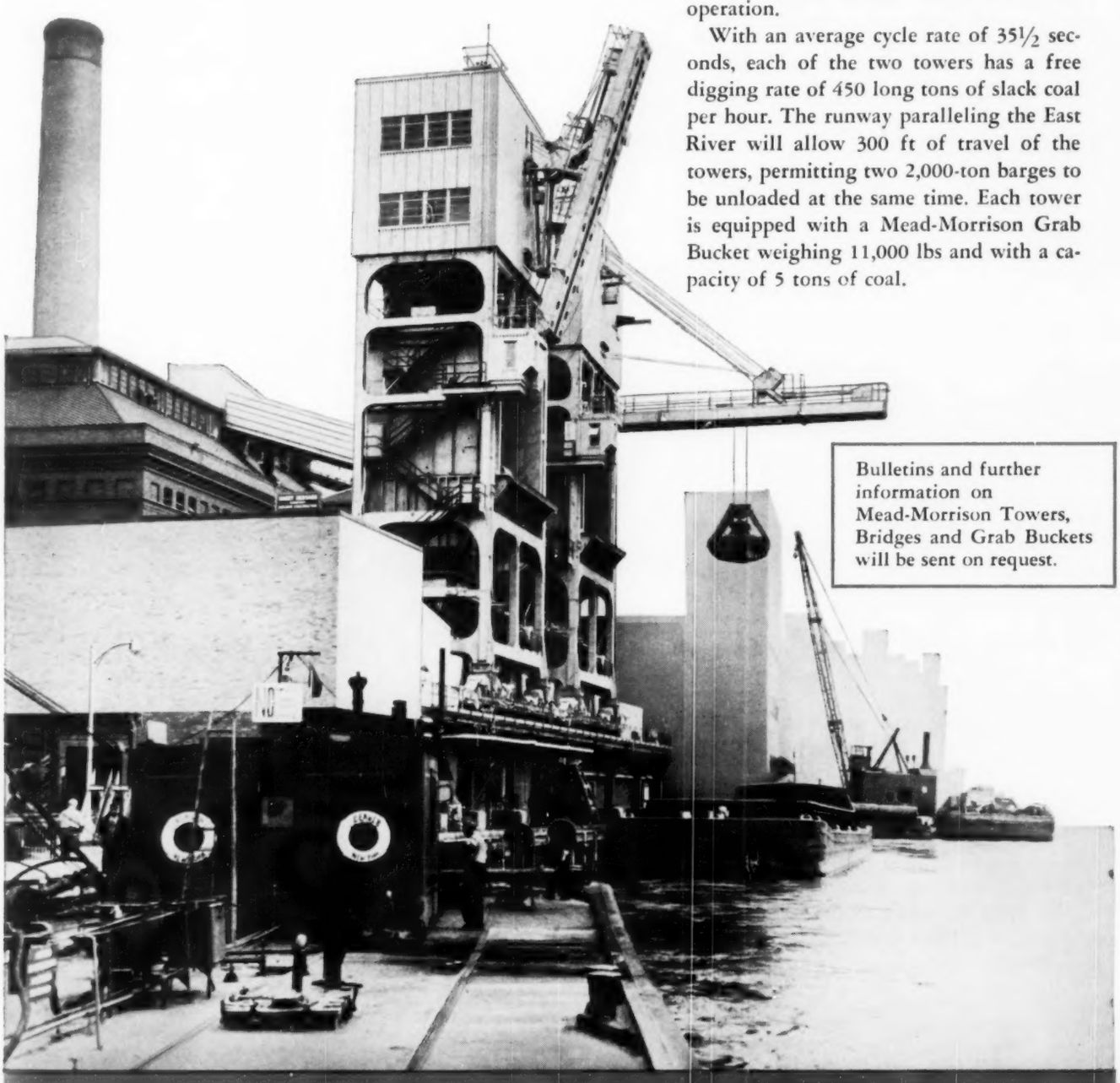
ENGINEERS AND MANUFACTURERS SINCE 1896

Speedy coal handling

for a New York subway power plant

The power station of the New York Transit Authority at 74th Street and East River has installed two new Mead-Morrison Coal Unloading Towers as part of its extensive modernization program to increase subway power. Because of their prominent position alongside the East River Drive, the towers were specially designed by Mead-Morrison to meet aesthetic standards as well as to include the most modern features for efficient operation.

With an average cycle rate of 35½ seconds, each of the two towers has a free digging rate of 450 long tons of slack coal per hour. The runway paralleling the East River will allow 300 ft of travel of the towers, permitting two 2,000-ton barges to be unloaded at the same time. Each tower is equipped with a Mead-Morrison Grab Bucket weighing 11,000 lbs and with a capacity of 5 tons of coal.



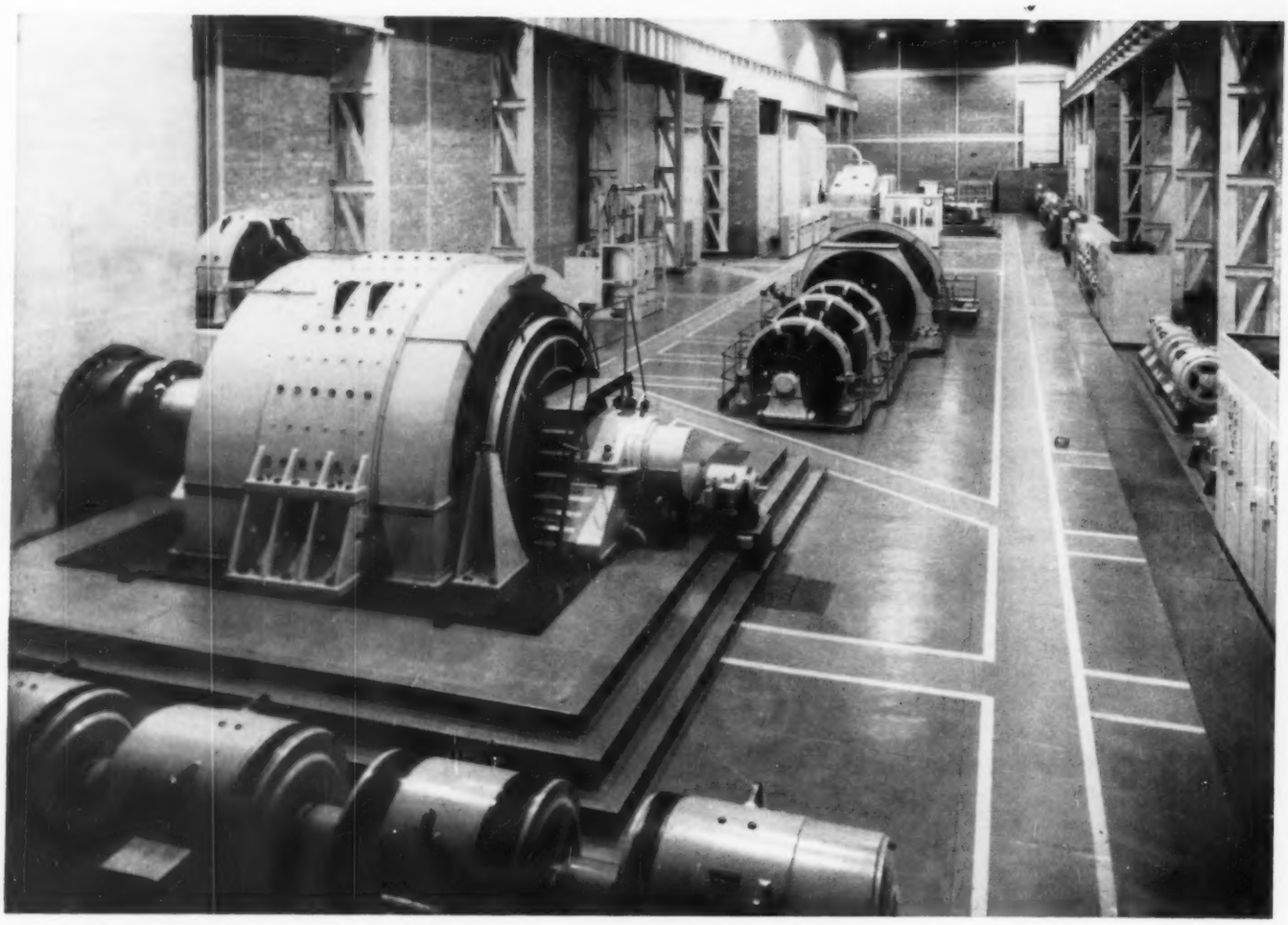
Bulletins and further information on Mead-Morrison Towers, Bridges and Grab Buckets will be sent on request.

MEAD-MORRISON

Division of McKIERNAN-TERRY CORPORATION · Manufacturing Engineers

HARRISON, NEW JERSEY

MMB25



COMPLETE STEELWORKS ELECTRIFICATION

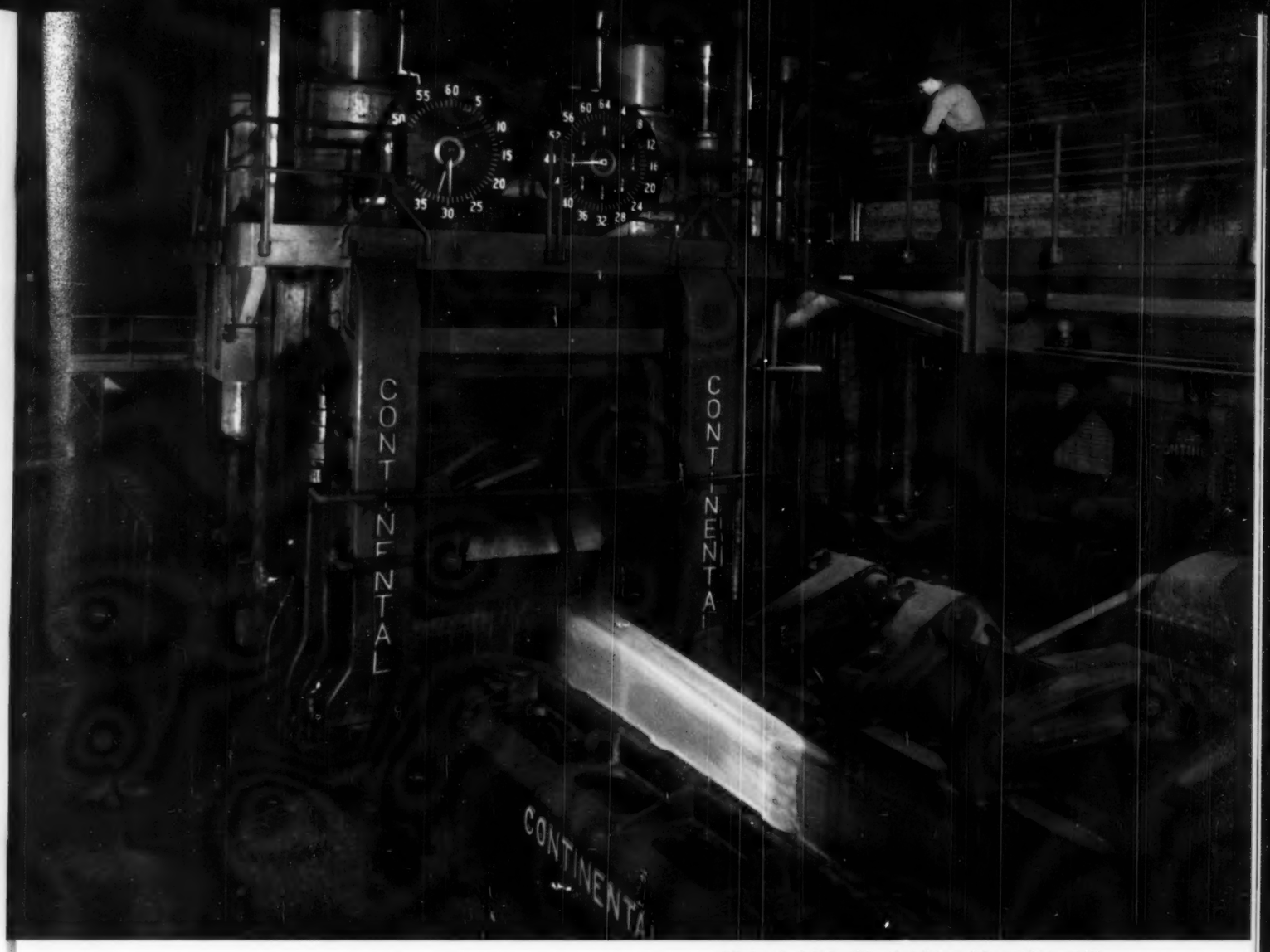
Complete projects are a specialty of English Electric. The typical example illustrated here shows the motor room of a modern steelworks. It contains a 7000 H.P. reversing plate mill drive with Ilgner set; a 1250 H.P. edger drive, scale breaker, and broadside mill drives of 1000, 1500 and 3500 H.P. These drives and the associated equipment were designed and built by English Electric.

If you are planning a complete steelworks electrification, or simply the addition for a small auxiliary drive, give us a call at any district office or write direct to our Metal Industries Division in St. Catharines or The English Electric Export and Trading Company Limited, Beaver Street, New York, N. Y. Our extensive experience is at your disposal.

'ENGLISH ELECTRIC' DIRECT CURRENT DRIVES

ENGLISH ELECTRIC COMPANY OF CANADA, LIMITED, ST. CATHARINES, ONT.
VANCOUVER, EDMONTON, CALGARY WINNIPEG, TORONTO, OTTAWA, MONTREAL AND HALIFAX

PA-5774



46-inch high lift slabbing-blooming mill

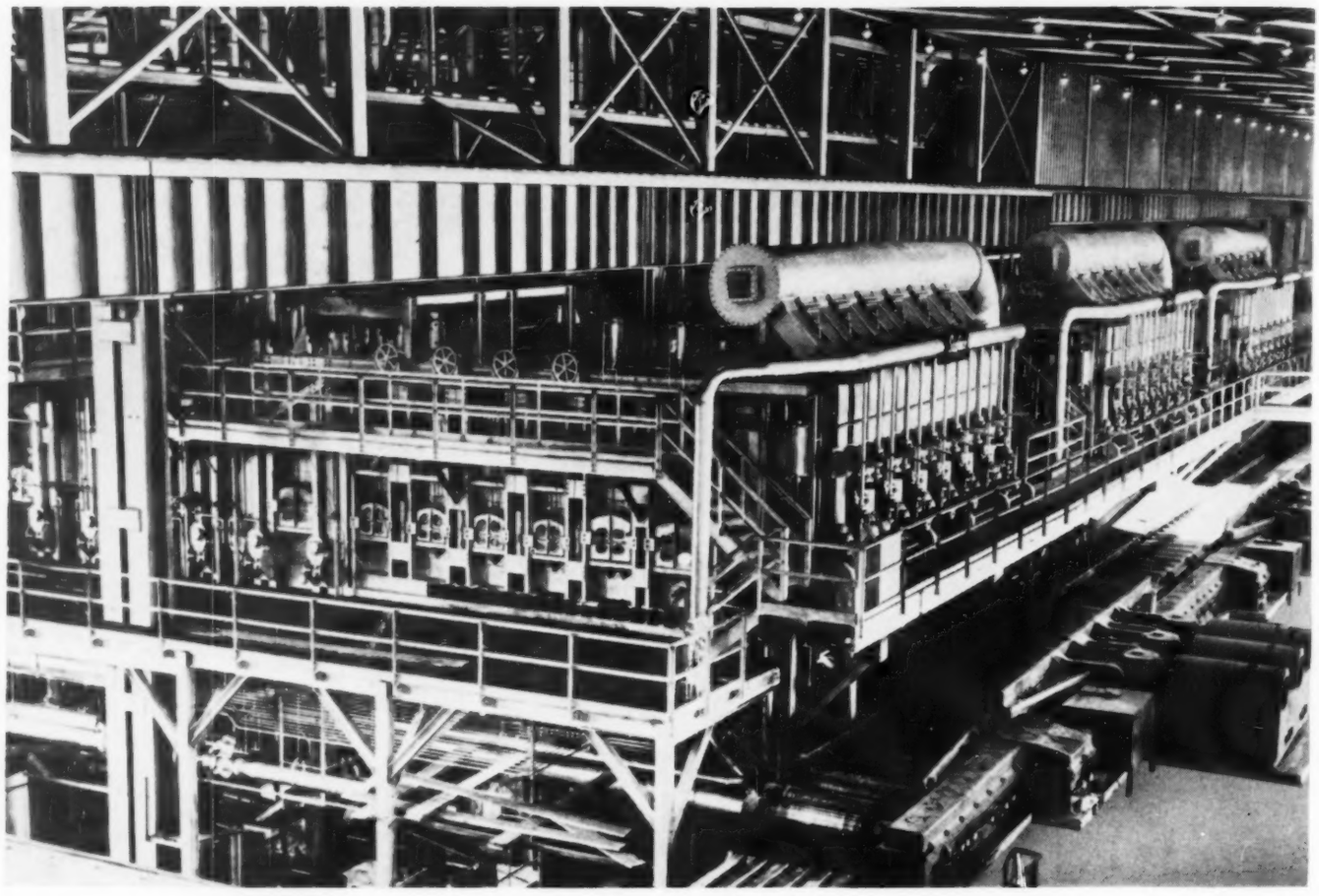
BLAW-KNOX SLABBING-BLOOMING MILLS

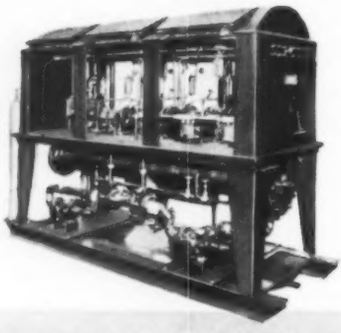
Blaw-Knox designs and builds slabbing-blooming mills in a complete range of sizes in high-lift and universal types. Other Blaw-Knox equipment for metals industry includes complete rolling mill installations including all auxiliary equipment for ferrous and non-ferrous metals, iron, alloy iron and steel rolls, Medart cold finishing equipment, carbon and alloy steel castings, fabricated steel plate or cast-weld design weldments, steel plant equipment, and heat and corrosion resisting alloy castings.

BLAW-KNOX

BLAW-KNOX COMPANY

Foundry and Mill Machinery Division
Blaw-Knox Building • 300 Sixth Avenue
Pittsburgh 22, Pennsylvania





One of the nine Askania control housings for furnace pressure, fuel gas pressure, and fuel-air ratio in each of the three zones of the "Surface" slab heating furnaces at Weirton Steel. For economy of installation and accuracy of control, these nine control centers are located near the points of control, while the operators' control panels are remotely located at the upper burner elevation.

For the world's largest slab heating furnaces...

ASKANIA COMBUSTION CONTROLS

Askania automatic control equipment helps to maintain top operating efficiency for these three slab heating furnaces—the largest in the world—designed and built by Surface Combustion Corporation for Weirton Steel Co. Division of National Steel Corporation.

Each furnace is 116 ft. long, and wide enough to take 26-ft slabs. The three zones of each furnace have independent Askania control systems for furnace pressure, fuel gas pressure, and fuel-air ratio.

Every year, more and more steel mill furnaces—blast furnaces, open hearths, soaking pits, heating furnaces—are Askania-equipped, because more and more steel men know that Askania is the straight line to easy and accurate control with equipment that's designed to take all the use and abuse of steel mill service. These are *controls for steel*—designed by Askania—*the men who know steel!*

Specify Askania controls for every furnace, coke oven, gas mixing, or blower control application. Call your local Askania office, or write direct to Chicago for your copy of the complete, informative Askania catalog.

STRAIGHT-LINE AUTOMATIC CONTROLS FOR INDUSTRY
•
SERVOMECHANISMS
•
SYSTEMS ENGINEERING
•
VALVE ACTUATORS AND CYLINDERS
•
HYDRAULIC POWER AND PRECISION FOR AUTOMATIC CONTROL

ASKANIA

GENERAL PRECISION EQUIPMENT CORPORATION GPE

ASKANIA REGULATOR COMPANY · 246 East Ontario Street · Chicago 11, Illinois

Convertible Rolling Mill Compacts powders into sheet and strip

A NEWLY developed horizontal rolling mill which compacts metal powders directly into sheet and strip and which is also convertible to a vertical 2-high/4-high combination mill was demonstrated recently at the Westbury Suburban Industrial Park facilities of Stanat Manufacturing Co., Inc.

For the metal powder rolling operation, the mill was designed to produce both ferrous and nonferrous materials in widths up to 7 in. and thicknesses ranging from $\frac{1}{32}$ to $\frac{1}{8}$ in., depending on the particular metal powder being processed. In performance tests the machine successfully compacted such widely diverse metal powders as aluminum, stainless steel, molybdenum and tungsten.

The Stanat machine is expected to be a boon to research, development and pilot production activities concerned with the fabrication of such critical items as nuclear fuel elements, aircraft filtration systems and new alloys for rockets and ballistic missiles.

Unusual flexibility of design permits the substitution of both wider and larger diameter rolls. For example, 10-in. diam x 12-in. face width rolls can be used instead of the 8- x 8-in. rolls with which the mill has initially been equipped. Capacities can thus be increased to produce sheet widths up to 11 in. and thicknesses in excess of $\frac{1}{8}$ in. with certain metal powders.

The new mill, designated Model TAH-625, can be used for both hot and cold rolling operations. High temperature resistant rolls equipped with electric cartridge heater elements can be supplied.

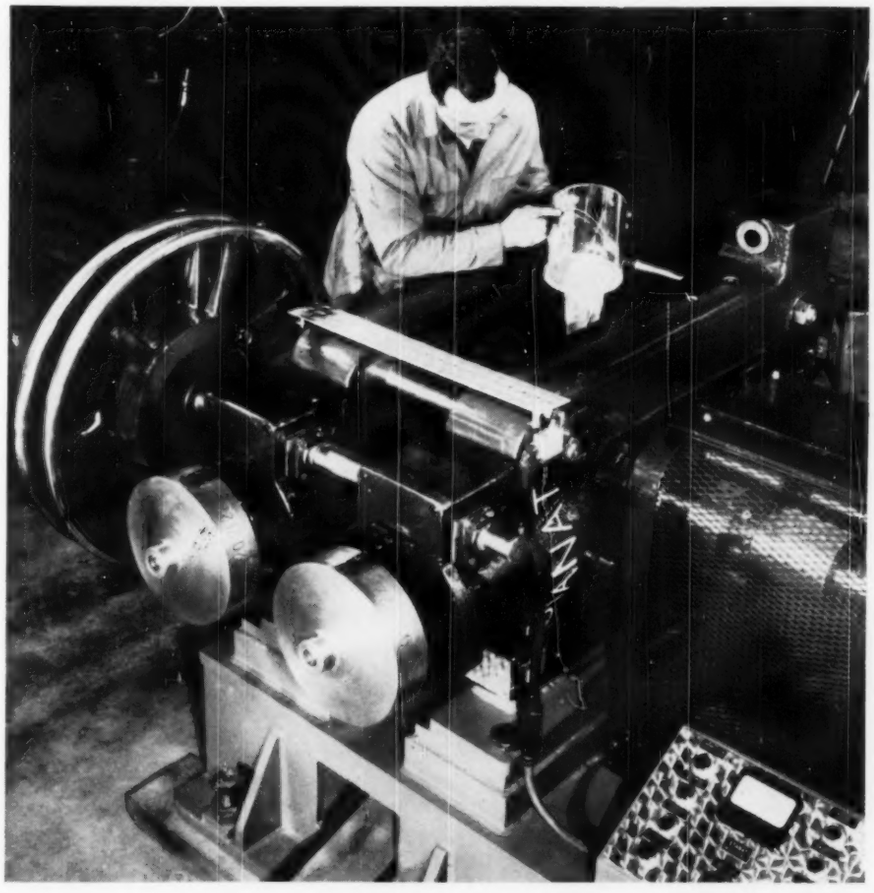
The compacting-by-rolling technique is, in principle, quite simple. The metal powder is merely poured between revolving rolls and a solid, uniform mass produced. Several variables such as roll diameter, roll gap and roll speed, determine strip qualities. Only a small amount of trial-and-error experimentation is required to achieve desirable strip formation of a given metal powder sample. Different methods of introducing material to the rolls may be employed by various hoppering techniques aided by vibrators for uniform feed rate.

Laminations may be produced by directing streams of dissimilar powders into the roll gap. Powder may also be compacted between strips of wrought metal to form a "sandwich" as is sometimes done in the manufacture of certain types of nuclear fuel elements. Impregnation of cloth with powder has been successfully carried out. Initial experimental feeding may also be done manually, with hoppering for high production.

For powder rolling operations, the rolls are arranged in a horizontal plane and a chute is provided on which the resultant strip is carried from the rolls. The width of the strip is controlled by side platens which are adjustable over the width of the rolls, enabling the formation of strip from $\frac{3}{4}$ in. and wider, up to almost the face width of the compacting rolls.

Material thickness is determined by roll diameter to a great extent and also by screw-down setting which controls the gap between the rolls. Certain powder samples are produced in strip thicknesses corresponding very nearly to the opening between rolls, whereas others may have twice or three times the thickness measurement of the roll gap through which the particles were

Figure 1 — Versatile mill handles materials in widths up to 7 in., in thicknesses from $\frac{1}{32}$ to $\frac{1}{8}$ in.



fed. Roll speed also has an effect, particularly on density.

Practically all metal powders compacted into strip must be sintered within a protective atmosphere such as hydrogen or argon to increase its strength and ductility. The process is usually completed by re-rolling the sintered strip in either a 2-high or 4-high rolling mill.

The unit was engineered for conversion to a 2-high/4-high combination backup driven mill, with rolls arranged in a vertical plane for conventional horizontal rolling. The same rolls used for the powder compacting operation may also be used for such 2-high work as breakdown and sizing or skin passing in addition to which they may serve as backup rolls in a four-high configuration.

The complete small work roll assembly may consist of rolls ranging from 2¼ in. diam down to ¾ in. diam. The horizontal powder mill is thus transformed into an efficient 4-high backup driven 4-high mill capable of reducing strip to ultra-thin gages. For instance by using ¾-in. diam solid tungsten carbide work rolls and proper tension equipment, the mill can produce strip as thin as 0.0005 in.

The machine weighs approximately 25,000 lb and costs about $35,000, depending on the type of drive and accessories supplied. Roll frames are constructed of high tensile cast steel with each housing post having a cross-sectional area of 56 sq in. Radial loads are taken by heavy-duty needle roller bearings and end thrust is controlled by ball bearings. The roll bearings have a maximum roll separating force of 350,000 lb at a rolling speed of 25 fpm and 2500 hr bearing life.

Torque arms drive the rolls from a fully enclosed pinion stand which houses herringbone gears that run in an oil bath. The torque arm design permits rapid roll change-over and smooth delivery of power.

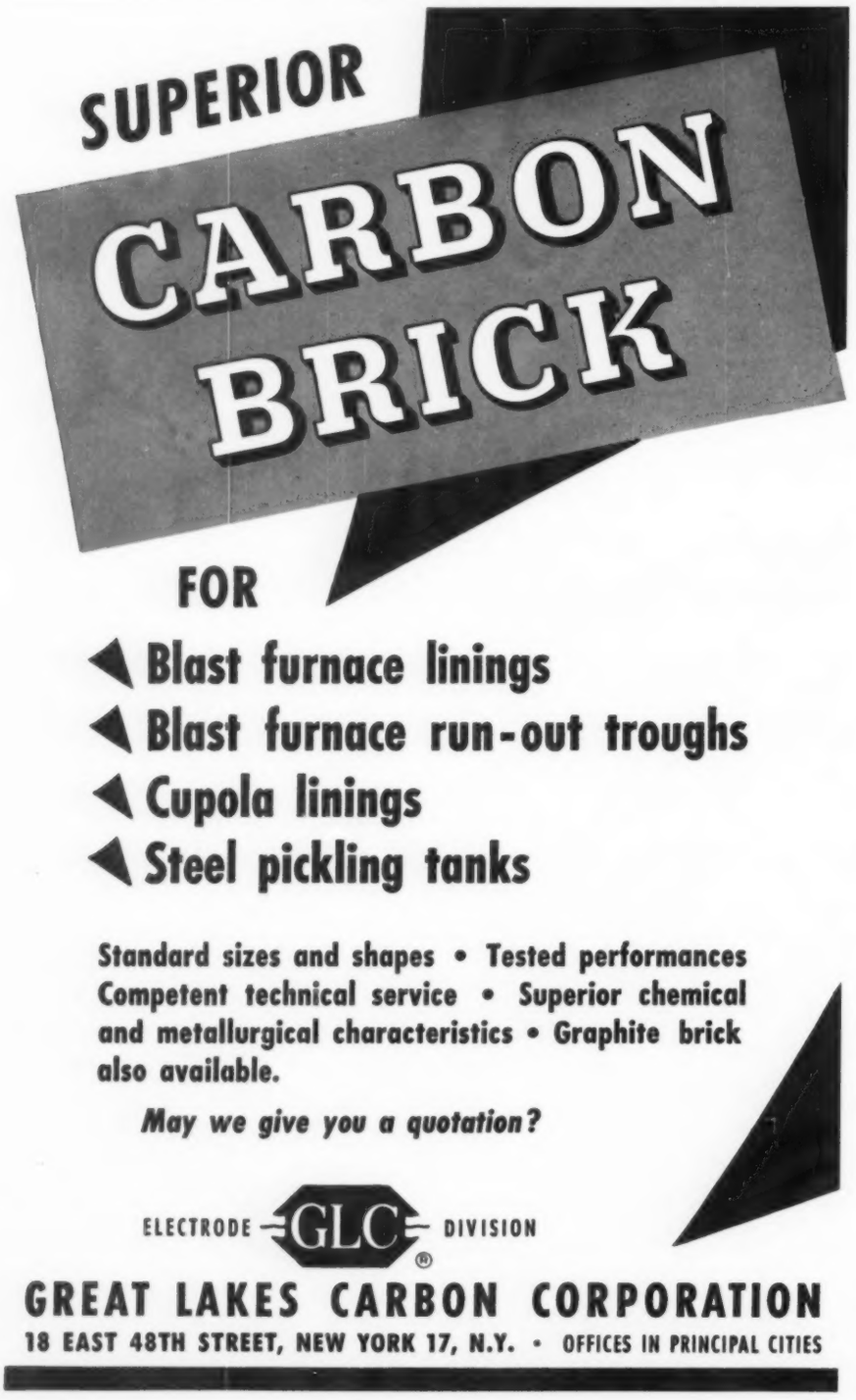
Roll adjustment is controlled by a dual handwheel worm gear screwdown with two micrometer dials graduated in 0.001 in., each handwheel revolution being equivalent to a screw movement of 0.10 in.

A heavy welded steel base supports the mill, pinion stand, motor and motor drive with switches conveniently located to give the operator complete control. Numerous safety features include guarding of all moving parts and emergency stop panels.

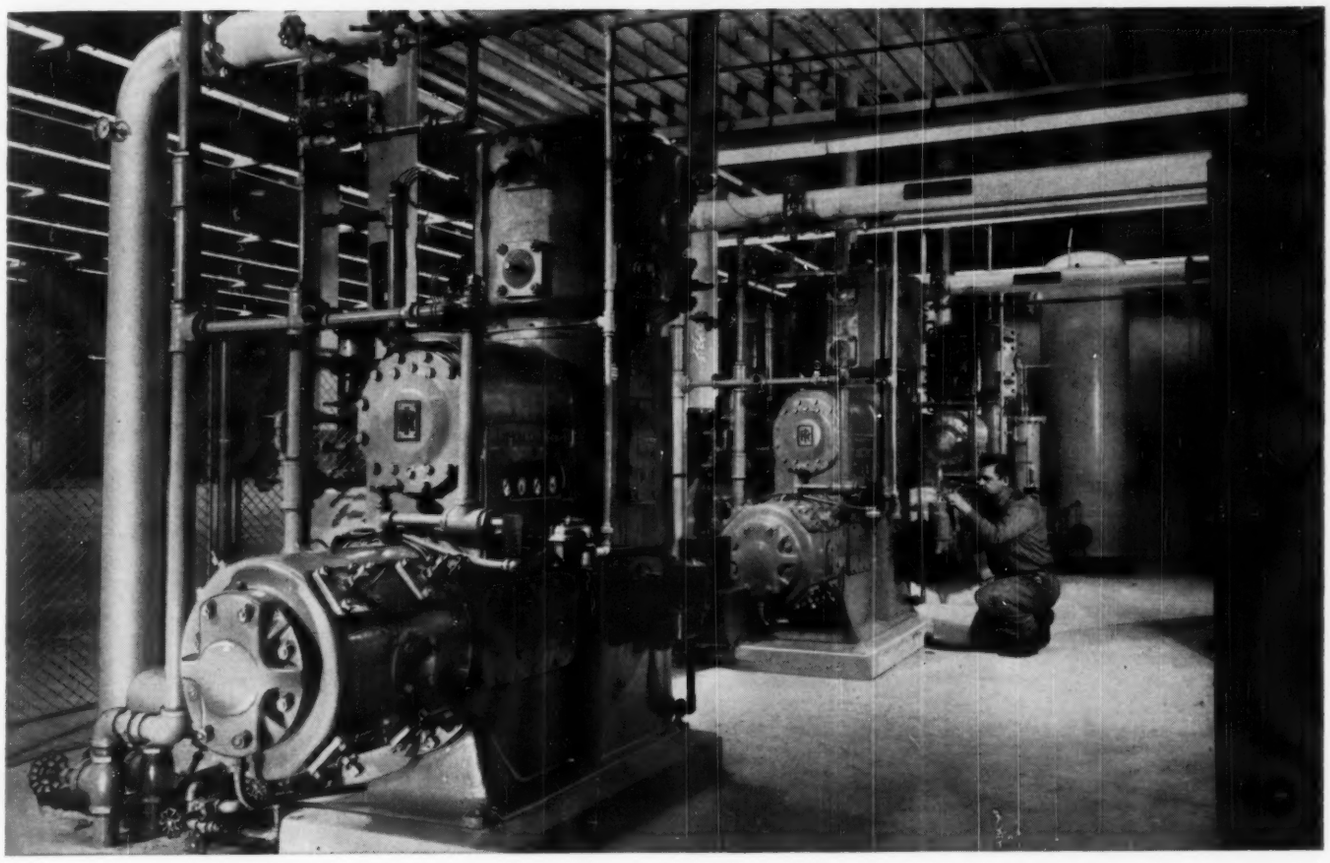
The machine is powered by a 25-hp continuously variable speed drive which is equipped with an electromagnetic brake for instantaneous stopping. The drive is geared to operate from near zero to 25 fpm. Other types of drives and speed arrangements can be provided to suit each user's requirements.

A pioneer in the development of advanced precision rolling mill machinery, Stanat Manufacturing Co. introduced and marketed the first commercially available metal powder rolling mills—considerably smaller counterparts of the TAH-625.

These mills are being used by such organizations as E. I. du Pont Engineering Laboratories, P. R. Mallory Metallurgical Facilities, Sylvania Bayside Metallurgical Laboratory, Westinghouse Commercial Atomic Power Activity, The Martin Company Nuclear Division, The U. S. Naval Ordnance Laboratory and the University of British Columbia. ▲


SUPERIOR
CARBON
BRICK
FOR
◀ Blast furnace linings
◀ Blast furnace run-out troughs
◀ Cupola linings
◀ Steel pickling tanks
Standard sizes and shapes • Tested performances
Competent technical service • Superior chemical and metallurgical characteristics • Graphite brick also available.
May we give you a quotation?
ELECTRODE GLC DIVISION
GREAT LAKES CARBON CORPORATION
18 EAST 48TH STREET, NEW YORK 17, N.Y. • OFFICES IN PRINCIPAL CITIES

FOR SUPERSONIC AIR POWER

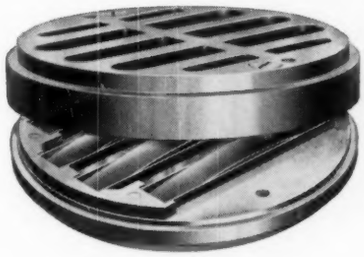


Ingersoll-Rand XLE compressors provide dependable plant air for North American Aviation—specialists in supersonic flight

At North American Aviation's Los Angeles (Calif.) Division—where tomorrow's supersonic flight is being developed today—these three Ingersoll-Rand XLE compressors are on duty around the clock, providing a never-failing supply of air power.

These modern packaged-design compressors save valuable floor space and are shipped fully-assembled, ready to install on a simple foundation. "Thru-frame" air flow eliminates interstage piping. Full-floating aluminum bearings are foolproof—sealed crankcase never needs to be opened for bearing adjustment, so dirt (the major cause of wear) is kept out of the oil. All moving parts are pressure-lubricated. Push-button starting and simplified operation are standard, and fully-automatic or remote controls can be supplied if desired.

These XLE compressors are built in sizes from 125 to 350 hp—other Ingersoll-Rand compressors are available from ½ to 6000 hp. Contact your I-R representative for help with your compressor problems.



AIR-CUSHIONED IR CHANNEL VALVES CUT DOWN-TIME

The heart of any compressor is its valving . . . Cut valve replacement and you've solved the No. 1 compressor maintenance problem. Ingersoll-Rand Channel Valves do just that. They are known the world over for remarkable durability, high efficiency and quiet operation. They are entirely different from any others—each valve is a combination of straight-lifting stainless-steel channels and leaf springs, with trapped-air spaces which cushion action and prevent impact. And only I-R compressors have Channel Valves.

Ingersoll-Rand

I-721 11 Broadway, New York 4, N.Y.

COMPRESSORS • GAS & DIESEL ENGINES • PUMPS • AIR & ELECTRIC TOOLS • CONDENSERS • VACUUM EQUIPMENT • ROCK DRILLS

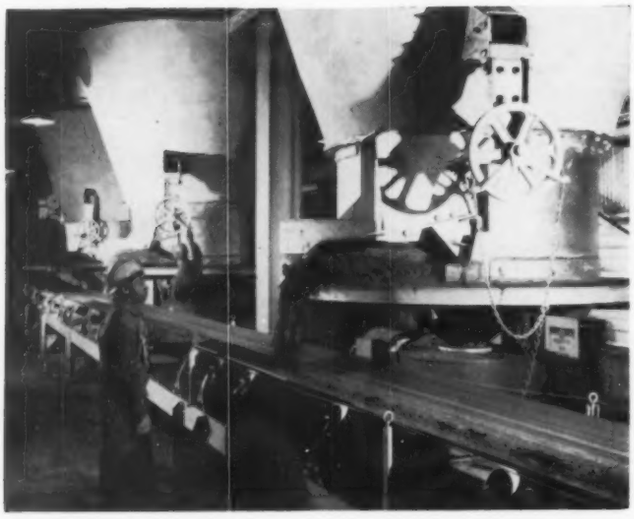
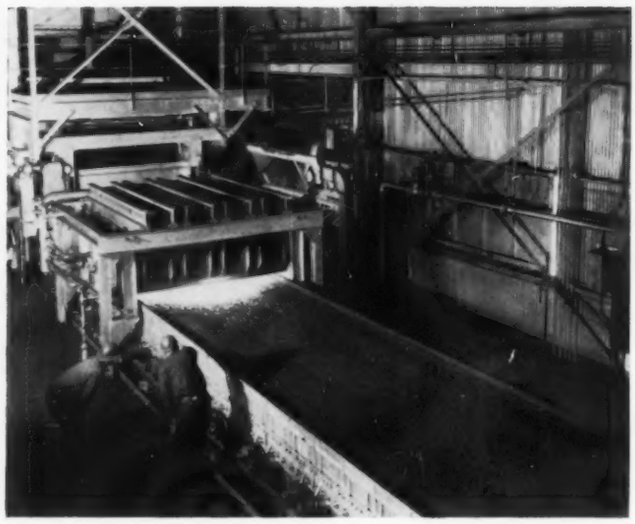


Figure 1 (left) — Proportions of materials in the mixture to be sintered are automatically controlled through electric belt scales which provide signals to regulate the rotational speed of the feeder disk under the hopper. Figure 2 (right) — The new sintering plant at Jones & Laughlin Steel Corp.'s Cleveland Works has a daily capacity of 2500 tons of sinter for the blast furnaces. This bed of sinter is 8 ft wide and 12 in. deep. The plant control console and instrument panel are beyond the ignition furnace. Sintering takes place along the 128-ft length of the porous bed through which air is drawn downward at 280,000 cfm.



J & L Installs Sintering Plant at Otis Works

A NEW ore sintering plant, installed at a cost of about $7,000,000, has been put into operation at the Cleveland Works of Jones & Laughlin Steel Corp.

The new sintering plant has a daily capacity of 2500 tons. It replaces an older facility which was averaging about one-sixth of the present capacity. As a result of this new installation, existing blast furnace capacity at the Cleveland Works will be increased to approximately 2500 tons of pig iron daily, a rise of about 300 net tons.

The sintering plant was engineered and constructed by Arthur G. McKee & Co., Cleveland.

Figure 3 — The instrument panel and control console incorporate the latest developments in automatic control. Seven of the indicator-recorders shown here, and three behind the control console, measure the weight of moving materials on conveyor belts electrically and in some instances transmit a signal for automatic controls.

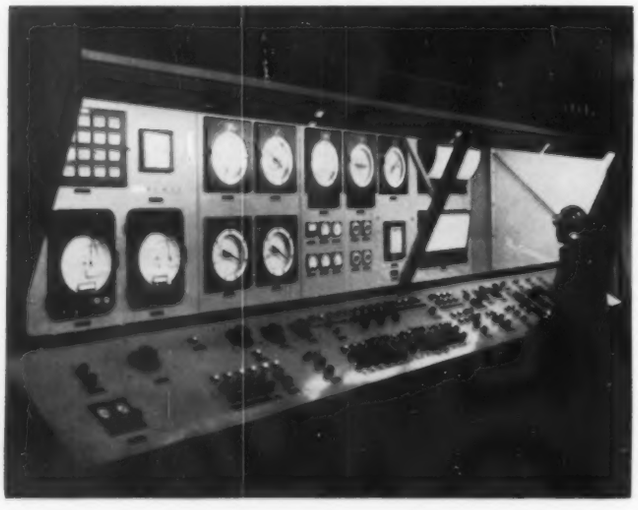
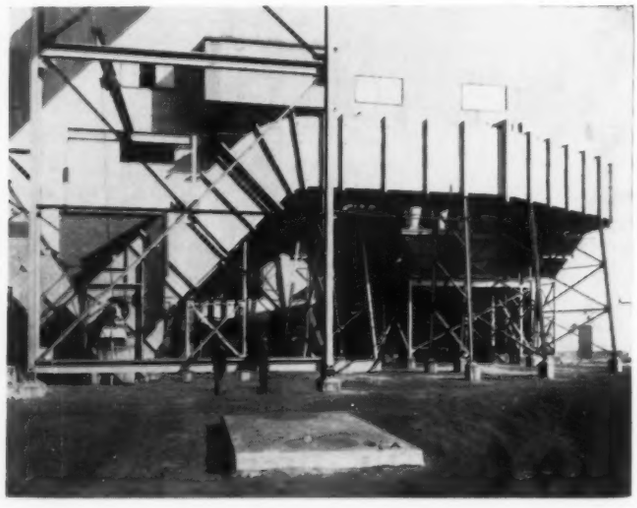
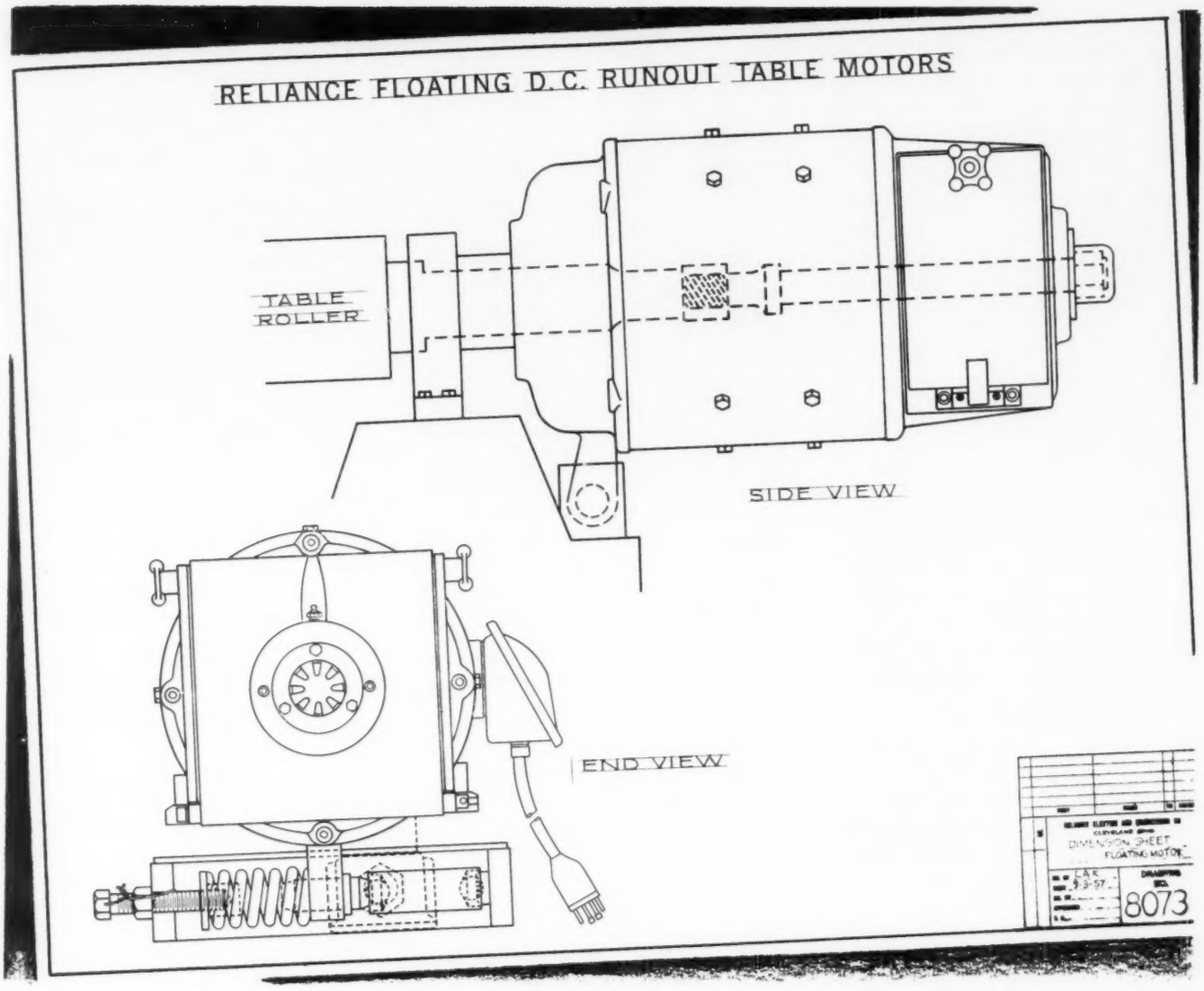


Figure 4 — Exhaust air is drawn through a 152-ft collector main and 16 cyclone dust collectors before being blown into a 150-ft stack. The fan (left) has a capacity of 280,000 cfm of air at 300 F. The impeller is nearly 9 ft in diam and is driven through a Gyrol fluid coupling by a 2000-hp motor.





Reliance runout table motors cut installation and maintenance costs

Reliance Hollow Shaft, floating motors are easy to install. They require no special pedestals or flexible couplings.

The hollow shaft motors fit right over the table-roller shaft. No special alignment is required. Warpage and backlash compensation are handled by the heavy tie-down spring. Not only are coupling maintenance and lubrication eliminated, but a much greater degree of roller misalignment can be tolerated.

Reliance Floating motors are designed and built specifically for runout table service. They are available with a wide range of speeds and out-put torques. For complete information contact your local Reliance Representative, or write for Bulletin No. F-2051. C-1587

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 113A, CLEVELAND 17, OHIO
CANADIAN DIVISION: TORONTO, ONTARIO
Sales Offices and Distributors in principal cities

Iron ore normally is screeened to remove the "fines" at J&L ore mines in Minnesota. However, there is some screening at the Cleveland works. In addition, "fines" are received from J&L reclamation facilities in Minnesota.

The sintering machine itself is a conventional Dwight-Lloyd traveling grate type with a traveling bed of material 8 ft wide and 128 ft long. The material may be 12 to 16 in. deep.

The speed of the traveling bed is automatically controlled within a range of 2.2 to 13.2 fpm, depending upon bed thickness as measured by a series of eight electrode probes of graduated length.

Speed of the roll feeder is automatically controlled by four electrodes in a surge hopper above it. Feeder speed depends upon the height of material in this hopper.

Sintering is accomplished by first igniting the fuel (coke breeze) in the sinter mix in a gas-fired ignition furnace at the head end of the machine. After ignition, the burning of the fuel and the fusing of the "fines" progress downward in the bed until the fuel has been completely burned. A continuous down-draft is maintained over the 128-ft length of the machine.

As the sintered bed of materials leaves the machine, it is broken up into lumps which fall on an oscillating screen. An air exhaust hood over the screen removes a portion of the dust and fines from the sinter.

After the sinter is air cooled in a

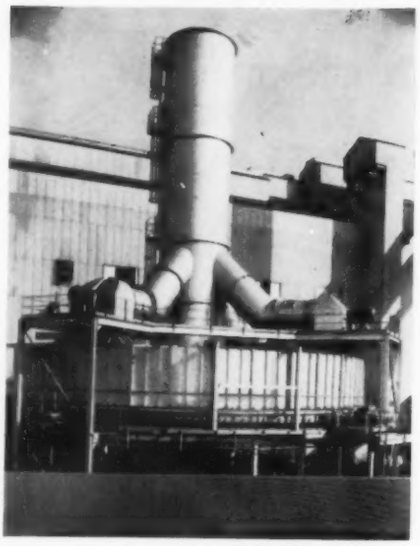


Figure 5 — Effective air cooling of hot sinter from J&L's new sintering plant at the Cleveland Works is achieved with a Dravo-Lurgi cooler. Approximately 450,000 cfm of cooling air (16 tons per min) are drawn up through the sinter by three fans and exhausted out the top of the 100-ft stack.

circular, 65-ft diam Dravo-Lurgi cooler, it is again screened and conveyed to loading bins which discharge by gravity either into a rail transfer car or a truck. If these bins are full, the sinter is transferred to a storage pile in the ore yard.

The air cooling equipment occupies a small space compared with that required by conventional straight-line cooling equipment. Approximately 450,000 cfm of air (about 16 tons) is drawn up through the hot sinter for 30 min as it moves 205 ft around the circular path, 65 ft in mean diam on 86-in. wide trays. This air is exhausted to a 16-ft diam central stack, 100 ft in height.

The volume of air used to cool the sinter is moved up through 1090 sq ft of cooling area by three fans driven by 100-hp motors. An additional 280,000 cfm of combustion air is required by the sintering machine and 40,000 cfm of air is used for dust recovery. Thus approximately 83 per cent of the plant's electric power is used for air movement.

All iron ore and other materials entering the sinter plant are weighed in motion on the conveyor belts by belt scales (Trans-Weight Co. Belt-Meters). All out-going sinter is weighed in the same manner. Twelve electric belt-scales are used in all, including those which weigh the quantities of moving materials at every important stage of the sintering operation.

Indicators, recorders, and controllers are located on central control panels to show the weight of the moving materials and to control automatically the desired proportions of materials fed to the belts and taken to the sintering machine. The indicators and recorders give the instantaneous flow in tons per hour and total the tonnages that have passed over the belt scales.

A feed ratio system controls the variable-speed table feeder drives which are regulated automatically by variations in weights of materials. Automatic transmitters regulate drive motor speed. ▲

Wallingford Steel Co. Adds New Mill Equipment

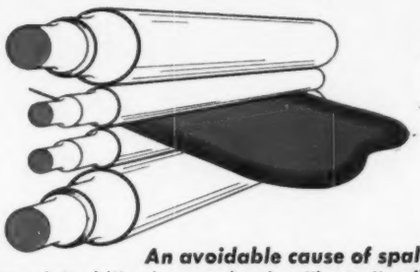
THE Wallingford Steel Co., Wallingford, Conn., announced the addition of a second sendzimir mill which permits the production of precision strip in widths up to 27 in. and as thin as 0.001 in., including thin gage strip for special applications such as turbine engines, guided missiles, aircraft components, etc. This new mill is equipped with the most modern x-ray gage equipment available. Gages, which are non-contacting and cannot mar the most highly finished surfaces, give continuous, extremely accurate readings. When the gage detects a deviation from nominal strip thickness, it transmits an impulse to two control

TIPS FROM A ROLL MAKER'S NOTEBOOK

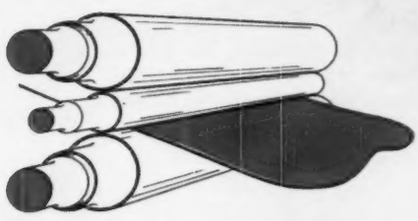
MACKINTOSH-HEMPHILL DIVISION, E. W. BLISS COMPANY, Pittsburgh 3, Pennsylvania

Cast mill rolls • Johnston cinder pots • rotary tube straighteners • end-thrust bearings • heavy-duty lathes • steel and special alloy castings

How to get longer life from plate mill work rolls



An avoidable cause of spalling: Uncropped "cold" edges and sides "bruise" rolls by causing over-stressing at the edges. Sub-surface fatigue cracks develop in these areas and roll starts to spall.

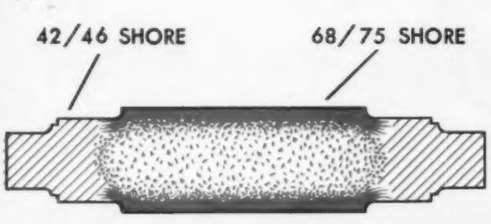


Some strength can be "swapped" for extra wear resistance in the middle roll of a 3-high mill, which gets approximately three times as much wear as the top and bottom rolls.

In plate mill work rolls, the balance of strength-vs.-hardness varies with the type of mill, the stand, and the rolling stresses involved. In general, however, the harder the rolls, the better.

This is particularly true of the work rolls in a 4-high mill and of the middle roll in a 3-high mill when used for finishing passes. On the other hand, the absence of grinding facilities in some plants often puts a limit on hardness, since the rolls must be soft enough to machine.

Spalling and fire cracking – With the many suitable combinations of mechanical properties available today, the life expectancy of a cast iron plate mill work roll depends largely on its resistance to fire cracking and spalling. And the current demand for good plate finish has placed even more emphasis on roll surface condition.



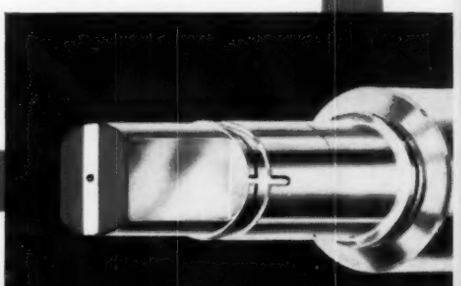
Triple-poured Nironite "F" roll, showing hardness ranges for the roll surface and the neck.

Three kinds of iron in a single roll – Mack-Hemp metallurgists have answered all these requirements in the *Nironite* "F" roll, a high-alloy grain-type roll.

Nironite "F" rolls are always double-poured, and sometimes even triple-poured. The deep outer shell is nickel-chromium alloy iron—very hard, very dense, and highly resistant to fire cracking. The second metal, a soft gray iron, provides the strength and resistance to impact needed in the core. Finally, the necks of all large Mack-Hemp plate mill rolls are cast with a third alloy whose carbon content is closely controlled. This third pour eliminates the tendency to weakness and coarse grain structure often encountered in the necks of double-poured plate mill rolls (a result of the slow cooling rate of the large mass of metal in the necks). It provides increased strength and a fine grain structure that prolongs the life of the roll neck bearings.

Another Nironite grade—*Nironite A*—is also widely used for work rolls in many plate mills. A single-poured cast iron grain roll of slightly lower alloy content than the iron of the first pour in Nironite "F" rolls, it provides excellent strength properties at somewhat lower hardness levels.

No matter what type of rolling you do . . . ferrous or non-ferrous . . . Mack-Hemp roll engineers and metallurgists can help you with your special problem. Simply write Mackintosh-Hemphill Division, E. W. Bliss Company, 901 Bingham Street, Pittsburgh 3, Pa.



MACKINTOSH-HEMPHILL

You get more tonnage from the rolls with the Striped Red Wabblers

Division of E. W. BLISS COMPANY

Presses, Rolling Mills, Special Machinery

Figure 1 — Wallingford's new sendzimir mill, equipped with the most modern x-ray gage equipment available, produces precision strip in widths up to 27 in. and as thin as 0.001 in.

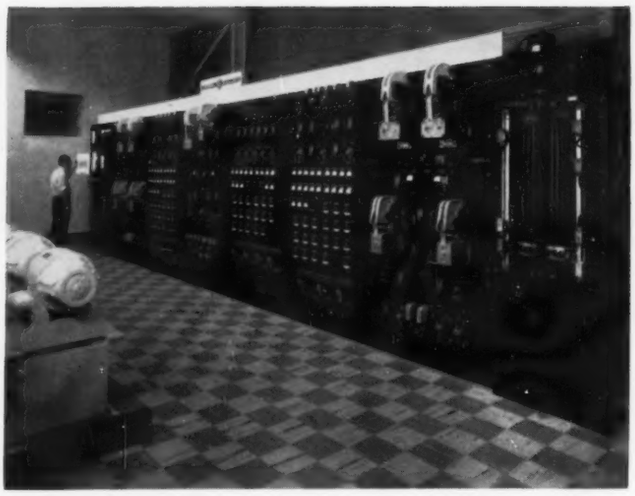


Figure 2 — Electrical controls required for the operation of Wallingford's new sendzimir mill are mounted on convenient panels.

units which operate to bring the strip back to size automatically. One control corrects the mill screwdown, the other adjusts the tension.

To supplement the gages described above, this new mill also utilizes exclusive elongation gaging equipment developed for use principally on "hardening passes" and similar rolling operations for the accurate measurement of thickness reductions that are too small to be detected by conventional methods which measure thickness directly.

As an additional means of assuring rigid quality control and to lessen the possibility of error, this new sendzimir mill at Wallingford Steel is equipped with a numerical control system. Under this method, the operator inserts an IBM card into the control mechanism. This automatically "presets" the mill to the required strip thickness.

This new mill is only one recent addition to Wallingford Steel's facilities. In addition, new bright anneal equipment is now in use to enable Wallingford to handle strip up to 27 in. wide and down to 0.001 in. in thickness. It is stated that the products manufactured from metal produced with this new bright anneal equipment require very little buffing to attain a mirror-like finish.

The addition of this new annealing equipment broadens the range of sizes, affording versatility which enables Wallingford to enter new markets, a move not heretofore possible.

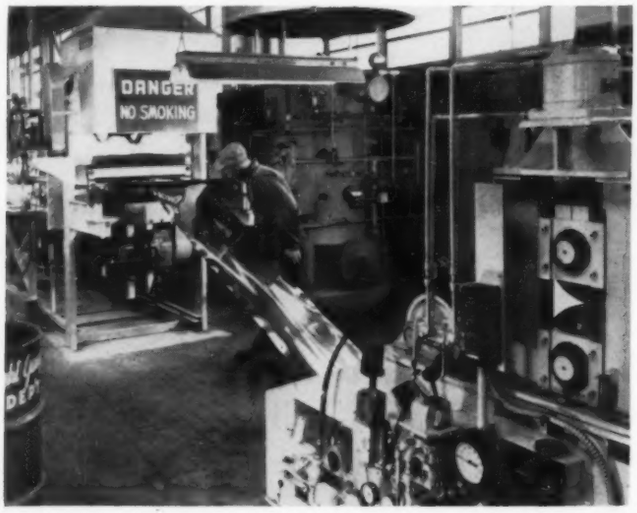
Other furnaces in operation include the gas-fired, open type that are used with pickling tubs which remove the oxide resulting from heating, and the gas-fired, muffle type using a dry hydrogen atmosphere and requiring no pickling process.

The manufacturer also reports that an all-new metallurgical laboratory is among the improvements recently made in Wallingford Steel's facilities and services. This new laboratory includes a metallographic section, analytical section, special testing section, technical library and conference room.

Although the manufacturer emphasizes that the expansion of facilities is a continuing program at Wallingford, it is especially appropriate that such significant improvements as those reported above can be announced as the company, producers of strip, tubing and pipe—stainless, alloy and super metals—celebrates its 35th anniversary and makes plans for the future. ▲

Figure 3 — Motors and generators necessary to operate Wallingford's new sendzimir mill.

Figure 4 — Strip is inspected as it comes from the new bright anneal furnace.



Push the button . . . then check your watch!

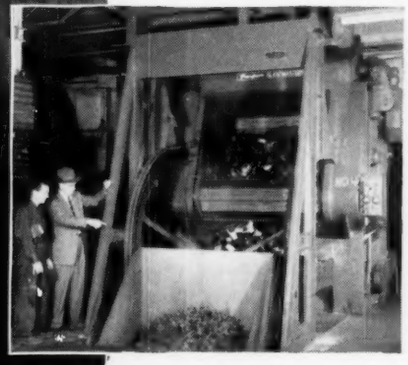
Rotoblast® cleans quickly and automatically . . . gives you *more* production with *less* manpower!

This control panel on the Pangborn Rotoblast Barrel is a symbol.

It stands for *speed*—push the Start button and a few minutes later you can push the one for Stop. It means *automatic operation*—just one man is needed to run it. And *quality,* too—between Start and Stop, whirling Rotoblast thoroughly blast cleans your castings to a silvery finish.

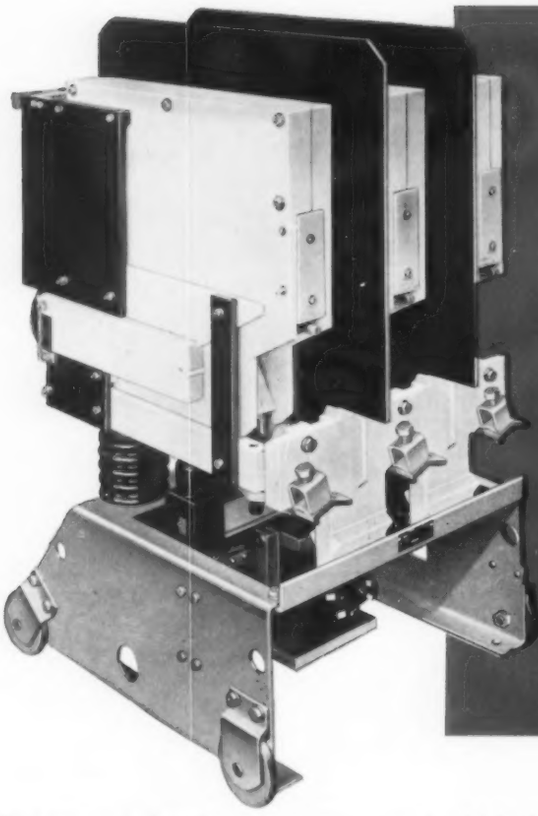
From original engineering through rugged construction to expert installation, Pangborn Rotoblast Machines are designed to satisfy you on every count—speed, performance, maintenance.

The Pangborn Engineer in your area will be glad to take off his coat and go to work on your *cleaning problem at no obligation. And, for more information, write today for Bulletin 227 to:* PANGBORN CORP., *4400 Pangborn Blvd., Hagerstown, Md. Manufacturers of Blast Cleaning and Dust Control Equipment.*



Pangborn Rotoblast Barrel for efficient batch cleaning. Available in 1½, 3, 6, 12, 18, 30 and 72 cubic foot sizes.

Clean it fast with **Pangborn ROTOBLAST**



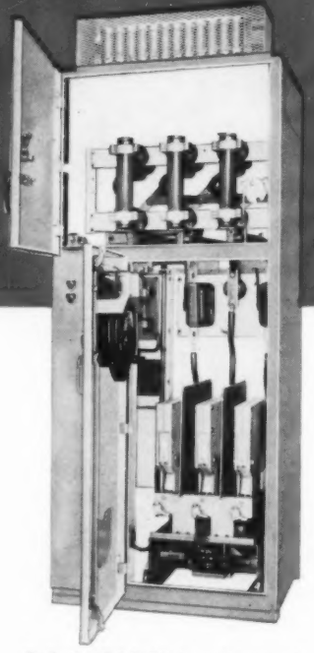
Air break starters
for high voltage motors

A-B QUALITY

This *new* air break contactor—around which Allen-Bradley has developed a complete line of high voltage starters—is designed to match your *toughest* applications. It features the same solenoid design—with only *one* moving part—that has made Allen-Bradley low voltage starters universally recognized for their tremendous operating life.

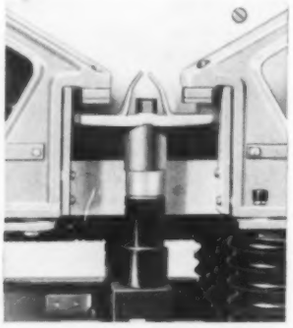
These new contactors are available in full voltage and reduced voltage starters—nonreversing or reversing—for squirrel cage, part winding, slip ring, and synchronous motors up to 1500 hp, 2300 volts; 2500 hp, 4600 volts. All starters are equipped with current limiting fuses and have an interrupting capacity of 150,000 kva at 2300 volts and 250,000 kva at 4600 volts.

It will pay you to investigate these *quality* starters. Complete information is contained in Publication 6080 . . . please send for your copy, today.

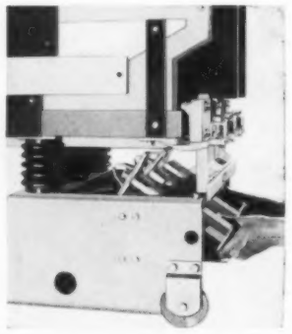


Bulletin 966 high voltage air break, across-the-line synchronous motor starter in NEMA Type 1 enclosure.

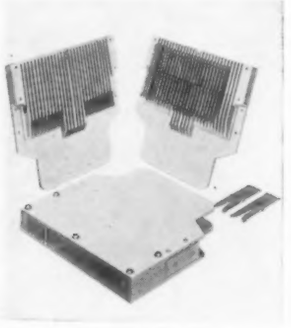
Only One Moving Part. Simple solenoid design eliminates trouble-causing pins, pivots, and flexible jumpers.



Double Break Contacts of silver alloy never need maintenance. Vertical motion assures uniform contact pressures.



Easy Access from Front. Crossbar and contacts removable from front, without special tools, for easy inspection.



Faster Arc Suppression. New blowout design and novel arc chute. Chutes are molded from an arc resistant material.

Allen-Bradley Co.
1343 S. First St.
Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd.
Galt, Ontario

ALLEN-BRADLEY
MOTOR CONTROL
QUALITY

Model Studies Expect to Improve Steel Plant Precipitator Operation

AMERICAN industry is keenly aware of the problem of air pollution and spends more than $1,000,000,000 per year to reduce pollution. Many types of equipment are used from mechanical collectors through cyclone-type collectors to high efficiency electrostatic precipitators. While mechanical collectors remove larger and heavier particles from industrial gases, electrostatic precipitation is required to remove particles of small size from 0.1 to 40 microns.

Research-Cottrell has operated an electrical laboratory and research department since the discovery of electrostatic precipitation as a useful commercial process 50 years ago. Refinements in electrical precipitation have been made constantly by laboratory work, pilot plant studies and field testing until today precipitation efficiency of over 90 per cent are common and a few have reached 99.9 per cent.

However, precipitators have always been sold on a "flange to flange" basis. In fact all parts of a power plant are purchased as separate units. The precipitator manufacturer submits a bid on the precipitator only. He does not design the flues leading to and from the precipitator and has no authority and only limited influence on flue design. In some cases he is shown the flue design and designs the precipitator large enough to make up for turbulent flow of gas into the precipitator.

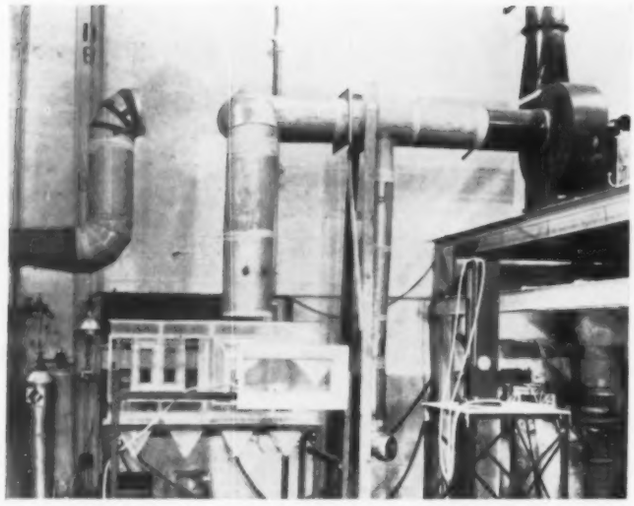
Neither does the precipitator manufacturer have any say in the design of major equipment directly preceding or succeeding the precipitator. Inasmuch as each manufacturer wants to take up as little space as possible and submit the lowest possible bid, short ducts and sharp, right angle turns are the rule.

Research-Cottrell believes that improved flue design will save money for industry. It is also felt that the best way to study flue design is by means of scaled working models so that gas flow patterns can be studied and velocity and pressure profiles can be obtained. Transparent plastic models are selected because of the ease of working, visibility of smoke through the plastic and ease of making model changes.

Two years of flue design in working models involving ten models has indicated several areas in which dollar savings to industry can be achieved.

Decrease in pressure drop—The greater the pressure drop through the flues, the larger the fan and motor must be to force or induce gas through the system. Industry estimates that a pressure drop has a direct dollar equivalent. Measured in terms of inches of water, each inch (w.g.) can be capitalized at from $40,000 to $80,000. Research-Cottrell has shown by models that it is possible to design flues to reduce pressure loss from ¼ in. to over 1 in. (w.g.).

Increasing capacity of precipitators—By bringing the gas to be cleaned to the precipitator in a more uniform manner, without turbulence and evenly distributed over all the plates, two approaches to precipitator design are possible. 1. Smaller precipitators can be used to attain a given efficiency. 2. A larger volume of gas can be treated in a precipitator of given size. In addition, the extra plate capacity designed into precipitators in the past because gas flow was erratic, is no longer required. The capacity



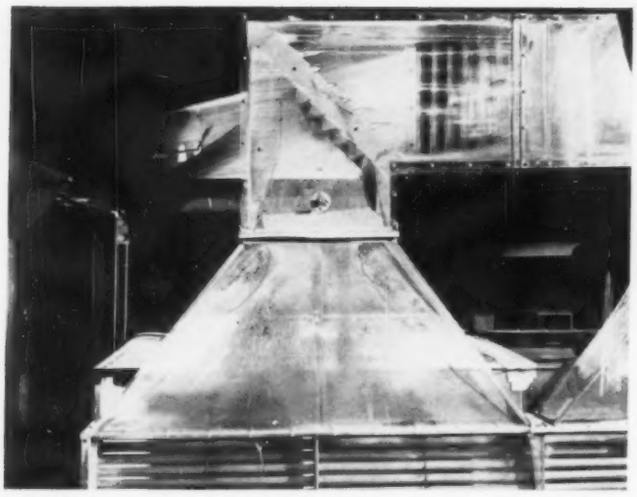


Figure 1 (left) — Room air is induced into the plastic model (center) of precipitator with air heater and flues by a 5000-cfm fan driven by a 25-hp motor (on scaffold). Velocity and pressure readings in the model are obtained by a precision micromanometer (on table at right) and pitot tube. Smoke to observe flow patterns is generated by gas tank and equipment at left. Model partially shown at left can be connected to fan by short length of duct. Figure 2 (right) — Dust separation patterns in exit flues of model show areas of low velocity and high turbulence. Gas is introduced into the exit flues from the precipitator by turning vanes. Precipitator part of model does not operate and is included in models only for its effect on gas flow and pressure drop.

"safety factor" is no longer needed.

Lower construction costs—Model studies have shown that certain components can often be eliminated or their function replaced by less costly devices. For example, by correctly designing a flue, drop-out hoppers can often be eliminated. Model studies showed that the hoppers increase and turbulence and pressure drop. Gas currents entered the hopper and stirred up as much dust as it trapped. Dust build-up can be prevented by soot-blowers. The material previously needed for hoppers and the labor of construction are eliminated.

Savings in precipitator design—Although not properly a part of the flue design study, improvements in precipitator design have already been made. Certain baffles in the precipitator itself formerly used to correct gas flow are now unnecessary, which lowers cost and pressure drop.

As in all research, many findings are basic and negative results are as useful as positive. For example, baffles, flow splitters or vanes have little or no effect on guiding gas flow in three dimensions. Further research with baffles has been stopped.

Most of the problems of gas flow in flues was found to involve shock patterns caused by sharp changes in flow direction, sharp changes in flue cross section and sharp changes in flue shape—from round to rectangular. The importance of maintaining the correct Reynolds number in shock pattern analysis has been found to be of little importance as long as it is above a critical value.

The proper utilization of perforated plates is of utmost importance. Model study shows, for example, that a perforated plate should not be placed in a vertical position over the opening in a hopper. In such a case, the gas flows under the plate sweeping dust out of the hopper. The open area of the plate is important. The distance from one plate to another is critical, as well as the distance of a plate from the precipitator. The effect of multiple plates is found to warrant further study.

An open space or slot is commonly designed between the perforated plate and the floor of the flue to allow the moving gas to sweep away the dust that might build up at the plate. Studies are now being made of the jet affect of the slot.

Research-Cottrell offers three types of contracts involving model studies. The first requires the building of a model, study of flue design and recommendations without a performance guarantee. The second is the same as the first except that performance is guaranteed. Under the third type of contract, Research-Cottrell undertakes responsibility for design, fabrication and erection of the flues and guarantees performance.

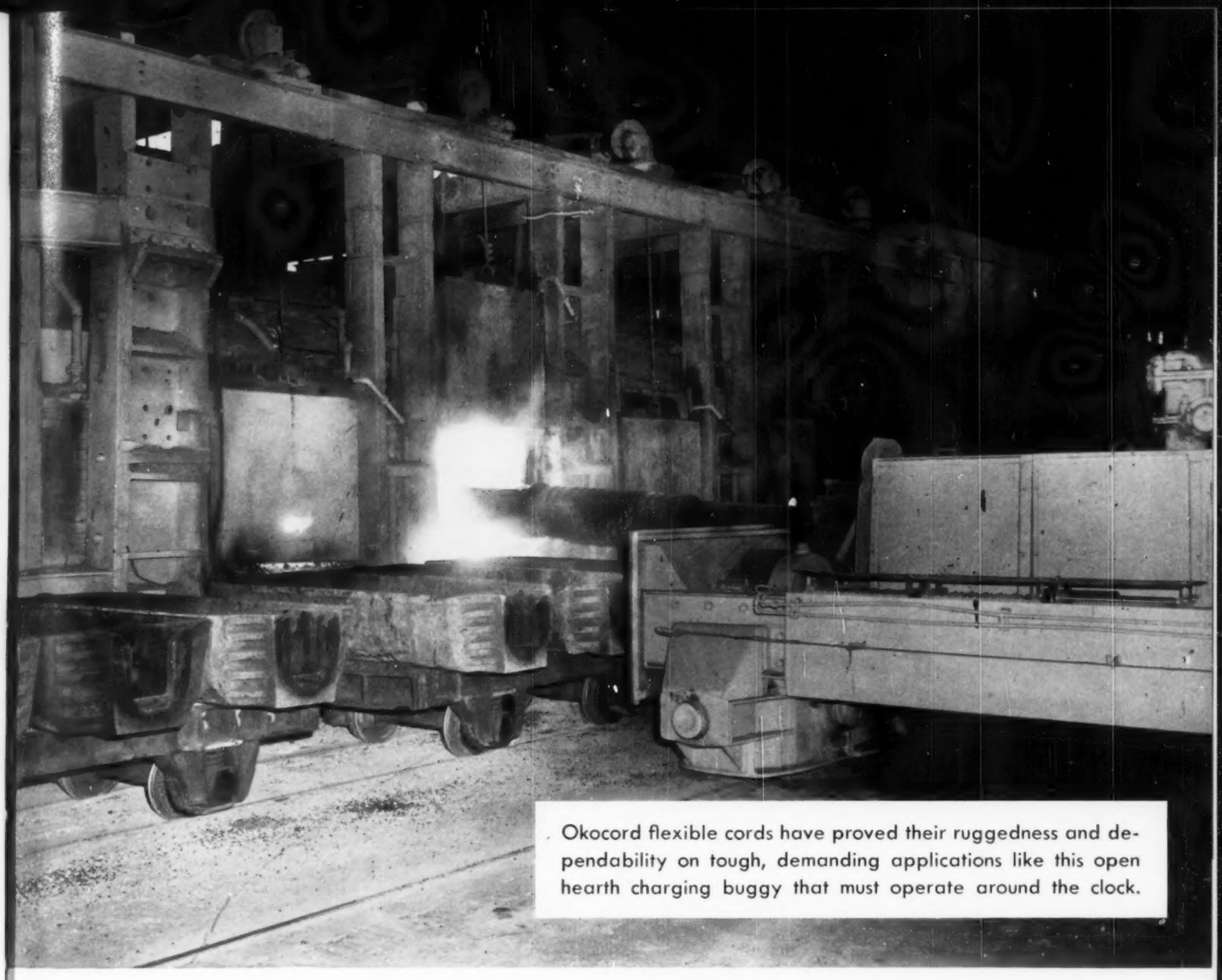
Studies of costs of the models built to date indicate that a model varies from 1 to 2 per cent of the cost of the precipitator.

A model can be built in 6 to 8 weeks after preliminary drawings have been prepared. An engineer in the model shop scales the drawings down to $\frac{1}{16}$ the size of the commercial size, or $\frac{3}{4}$ in. to 12 in. Four technicians cut the parts from $\frac{3}{16}$-in. flexiglas sheets using woodworking power tools such as a saw, sander, joiner and drill press. In a few models $\frac{1}{8}$- and $\frac{1}{16}$-in. sheets are used.

Two test engineers study flow patterns by means of threads, ribbons, ground cork or dust. Most flow pattern studies are made with smoke. Anemometers and pitot tubes are used to take velocity and pressure measurements.

Room air is induced into the models by a fan having a capacity of 5000 cfm at 21-in. water gage driven by a 25-hp motor. Two smaller blowers are also used.

Of particular interest to the steel industry are tests based on models simulating the cleaning system for the ferromanganese furnaces at U. S. Steel's Duquesne, Pa., plant. The effect of perforated plates on gas flow to a precipitator was studied in the model, since an improvement in performance of an existing installation was required. One special perforated plate was used before the precipitator in the existing plant. The special plate had holes of uni-



Okocord flexible cords have proved their ruggedness and dependability on tough, demanding applications like this open hearth charging buggy that must operate around the clock.

Heat and abuse . . . no problem for Okocord* portable cables

The charging machine above is controlled by Okocord flexible cables. They have to withstand constant heat and abrasion. And they're wound and unwound about a small reel every time the charging arm enters the furnace—literally hundreds of times every day.

Okocords are used for tough applications like this because they've been proved in service in steel mills . . . and in every other kind of plant. The rugged Okoprene sheath has superior flame resistance . . . plus the tire-tread toughness and extra flexibility that come from being cured in a continuous metal mold. The Okocord conductors have maximum flexibility because they are made of fine copper wires twisted together with a short lay.

Add to this Okocord's carefully-selected, tough, heat-resisting insulation and Okonite's reputation for superior engineering and manufacture . . . and you'll see why you should specify Okocord for every tough portable cord and cable application. Get complete details from your Okonite salesman or write for Bulletin IS-451. The Okonite Company, Passaic, N. J.

*This product formerly carried the trade name Hazacord

where there's electrical power . . . there's **OKONITE CABLE**

4903

form diameter punched on a specific grid pattern but certain rows of holes were omitted by design to provide a desirable pressure drop and flow. Velocity profiles taken in the model showed that the flow through the precipitator was not uniform using the special plate.

Gas flow through the model is now being studied using two standard perforated plates with holes punched uniformly over the entire surface of the plate. Some of the factors being studied include distance between the two plates, distance of the plates from the precipitator itself, position of the plates relative to changes in cross section of the flue, and open area of the plates. The results to be obtained should improve precipitator operation.

The installation designed for Duquesne consists of five precipitators, each preceded by a cooling and conditioning tower and arranged to handle the gases in parallel. Gas from the raw gas mains flows through the cooling tower where it is cooled and conditioned to approximately 450 F before it passes to the precipitators, which are of the standard horizontal flow, expanded metal steel plate type. Because of the importance of continuity of operation, isolating gas valves are installed to make it possible to take units out of service when repairs are needed. Dust plows are provided for each precipitator and conditioning tower hopper to assist in moving the dust to the dust handling system; continuous removal is essential to avoid packing. The dust collected is discharged to the pyrophoring kilns where it is oxidized before going to the mixers and briquetting machines.

Precipitators are important in five other steelmaking processes.

1. Open hearth precipitators—In this process, concentration of stack emission varies widely, anywhere from 0.18 to 1.2 gr per cu ft, during normal heat. The gas, containing fine fumes, is quite heavy in appearance. The cleaning problem involves combustion gases from open hearth furnaces that are usually oil or gas fired; in passing through the furnace these gases pick up metallic oxides which are then carried as suspended solids. The collected material is a heterogeneous chemical mixture, consisting chiefly of zinc, iron, lead and sulphur.

The adaptation of electrostatic precipitation designed for this situation consists of a standard steel collecting plate, horizontal flow fly-ash-type precipitator following a waste heat boiler and an induced draft fan. Plate rappers are of the magnetic impulse type while the high tension rappers are pneumatic vibrators operating on a time cycle.

Some installations incorporate what might be called a unit system principle, in that a separate precipitator is provided for each open hearth furnace. However, more recent studies indicate the desirability of combining gases from several furnaces and treating them in a central cleaning plant. This would create a leveling influence resulting in more uniform gas and dust conditions over the various furnace cycles.

2. Sintering machine precipitators—Here dust present in combustion gases contain approximately 65 per cent minus 44 micron particles. Consequently, to clean gases from iron ore sintering machines requires installation of an electrical precipitator after a mechanical collector, to reduce the amount of dust discharged. With the precipitator operating in series with the mechanical collector, precipitator efficiency can exceed 95 per cent. A horizontal flow plate type precipitator is used, with the gas discharging to atmosphere

Figure 3 — One important cleaning operation is in the blast furnace department.

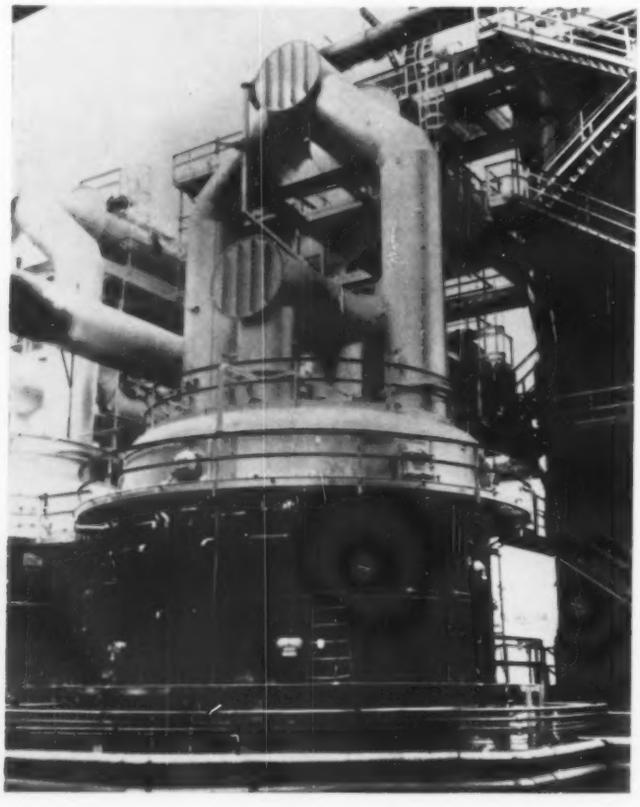
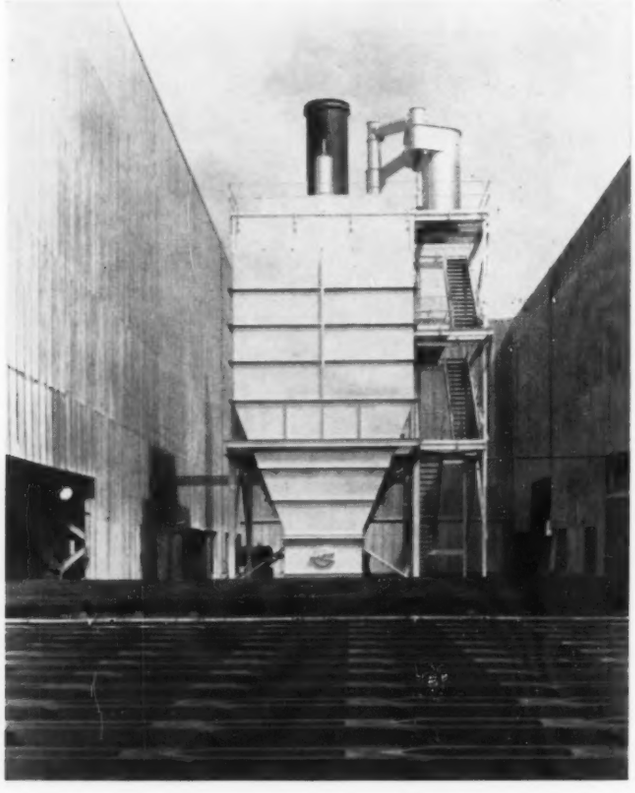
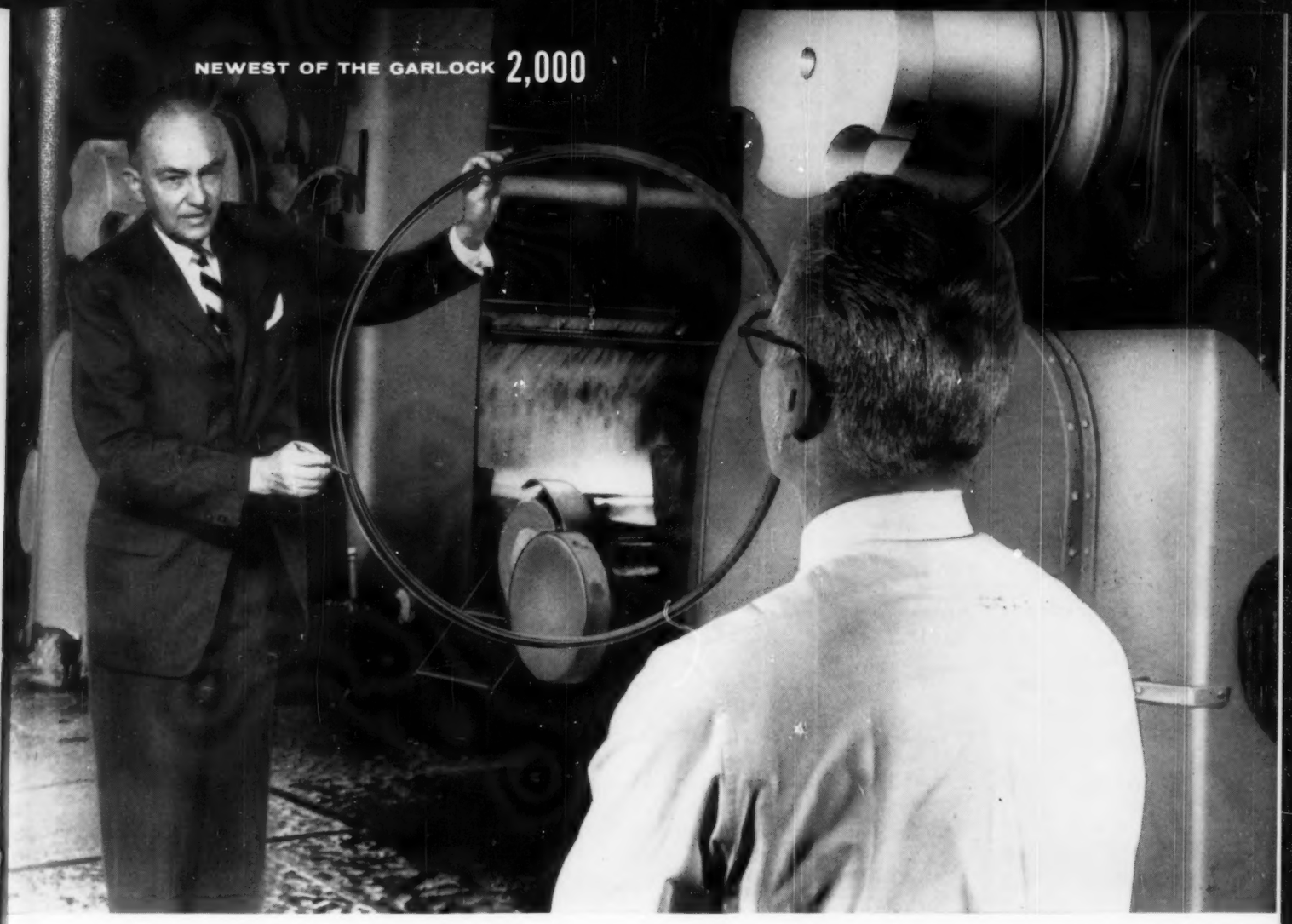


Figure 4 — Another important cleaning operation comes from scarfing.

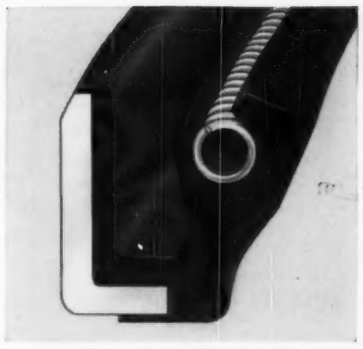




Garlock introduces new low cost KLOZURE* Oil Seals for large shafts

Here's a new KLOZURE Oil Seal that will save you money on initial installation and replacement. It's the new Model 2782 Garlock KLOZURE for large shafts up to 44" diameter operating at normal to high speeds, at temperatures to 275° F., on applications with low pressure differentials of approximately 5 psi. A garter spring holds the Buna-N sealing element in contact with the shaft. A precision formed case molded to the sealing element protects the seal from damage, and provides a press fit for proper installation.

Selection of a KLOZURE Oil Seal for your job is easier and more economical because Garlock has one of the largest stocks in the industry. And KLOZURES, of course, are just a part of the famous Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals for every need. The *only* complete line. Ask your local Garlock representative for his unbiased recommendation, or write for additional information on the Model 2782 KLOZURE.



Cross section Model 2782 Klozure

THE GARLOCK PACKING COMPANY, Palmyra, New York

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

*Registered Trademark

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

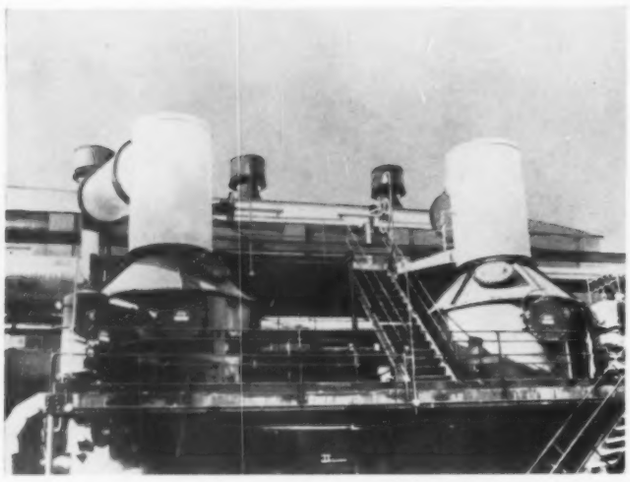


Figure 5 — Detarring operation at United States Steel Co.

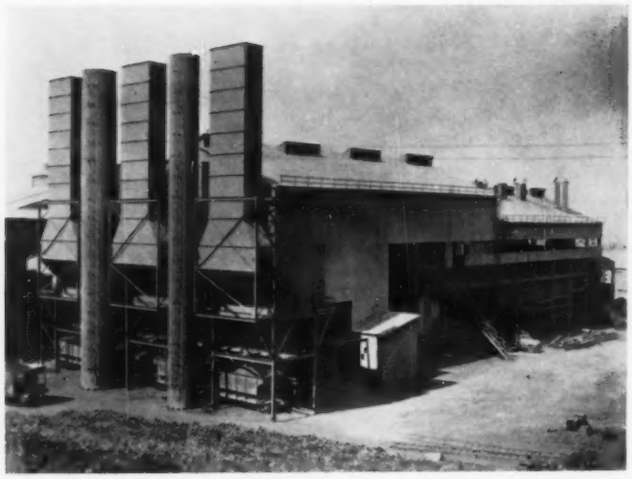


Figure 6 — Sintering operations set up major air cleaning problems.

through an individual stack on each precipitator. This recovery problem is unique in that much of the dust recovered is dust previously collected in gas cleaning equipment in other locations of the steel plant—in other words, much of the sintering feed is obtained from the dust catchers and precipitators operating on the blast furnace gas cleaning system.

3. Hot scarfing machine precipitators—The gas cleaning problem in hot scarfing machine operations is the removal of fine particles from ventilating systems. In the scarfing operation, slabs pass by the oxy-acetylene cutting torches at a speed of about 80 to 120 fpm. Sparks and fume are drawn down toward a target plate which is continuously sprayed with water. During the cutting operation a coarse spray of water is introduced immediately after the torch nozzles to break up the larger chips and wet the fume. The fume is taken to the precipitator through underground ducts; the clean gases are passed through a fan and are then exhausted to atmosphere.

4. Cupola installation precipitators—The basic problem is removal of solid particles from cupola gases. In normal practice, pig and/or scrap iron, together with coke and some limestone, are charged to the cupola, and blast air for combustion is blown in through tuyeres, located near the bottom. High temperatures are attained in the melting zone; some material is actually volatilized from the charge and later condenses to form fume particles when the gases are cooled. In addition, dust particles are picked up by the gases in their passage through the charge, and, as a result, the ultimate material to be removed is a mixture of fume and dust particles.

The gases are handled in one of two ways, depending upon the type of blast system used. In the cold blast system, the gases are drawn off and conducted directly to the cleaning equipment. Temperatures at the cupola exit usually range from 1200 to 2000 F. In the hot blast system, air heaters are used to preheat the blast air for the cupola. Gas temperatures at the outlet of the air heaters range from 500 to 800 F before entering the cleaning equipment.

In both systems the gas cleaning equipment is essentially the same. In either case gas must pass through spray cooling towers that reduce temperatures to about 300 to 400 F and increase moisture content to condition the gas for treatment in the precipitator. From the spray cooling tower gases pass to the precipitator, fan, stack and atmosphere.

5. Oxygen conversion precipitators—The most recent application of the Cottrell system to ferrous metallurgy is the design of precipitators to cope with the high volume of gases involved in the oxygen conversion process at the Aliquippa plant of Jones & Laughlin Steel Corp. This technology was previously limited by the scope of the gas cleaning problem. The precipitator now in operation is cleaning 238,000 cfm of gas with 99.5 per cent efficiency.

The dust control problem arises from the composition of the gases evolved from the process. Entrained dust consists mainly of iron oxides in sub-micron particles. It is estimated that for each ton of pig iron, about 34 lb of dust are discharged with 90 per cent being minus 1 micron in size.

The Cottrell precipitator that solved this problem is of the horizontal flow plate type, with two units, each with three 9-ft sections. Gases generated at the converter are burned with excess air and then cooled with water sprays to between 350 and 550 F before entering the precipitator. Some of this cooling takes place by radiation during passage from spark box to precipitator.

Since the units operate at efficiencies above 99 per cent, it is essential to maintain clean collecting plates. This is accomplished by continually operated and automatically controlled magnetic impulse rappers, designed so that cycle and intensity of electrode rapping can be varied to suit operating conditions. Discharge electrodes are kept clean by vibrators.

Two similar units have been ordered by Kaiser Steel Corp. for the Fontana plant, and are being designed for 99.8 per cent efficiency.

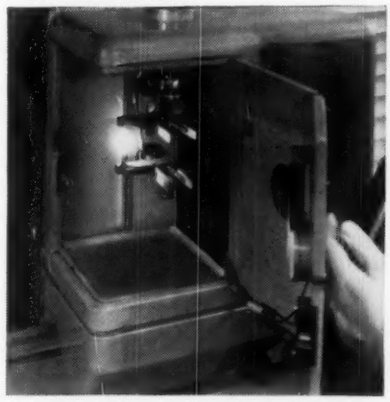
The number of precipitant installations emphasizes the iron and steel industry's efforts in the realm of smoke control. Since 1919 steel mills have installed a total of over 312 electrostatic precipitators, with a total gas cleaning capacity of over 22,500,000 cfm.

Of this total, it is estimated approximately 15,000,000 cfm were installed by a single gas cleaning equipment manufacturer, Research-Cottrell, Inc., Bound Brook, N. J. This same manufacturer placed in operation 3,383,000 cfm of new precipitator capacity during the period 1954–57. ▲

Assuring the dependability of B-L-H nonferrous castings . . . the probing eye of the spectrograph

The position and intensity of the lines shown by the microphotometer indicate the metallic content of the alloy under analysis in relation to the standard.

Spectrographic equipment includes (far left) the spectrograph; the excitation stand (door open), and the new 1000 v source unit purchased specifically for analysis of the copper base alloys.



Excitation stand immediately following burning of a sample of an alloy. Glowing white light indicates hot electrodes.

A truly vital factor in careful quality control of nonferrous castings at B-L-H's Eddystone Division is spectrographic analysis, a quick and accurate 2-step method. First the characteristic lines of colored light of each metal in the alloy being analyzed are registered on film in a highly controlled manner. Then, by interpreting the position and intensity of these lines, the composition of the alloy is determined.

B-L-H uses the spectrograph to check both incoming metal and outgoing castings. Each lot of virgin metal and each lot of prepared alloy ingots are analyzed to make certain they measure up to Baldwin's specifications. The casting, too, as it comes from the mold, is subjected to spectrographic probing, an evaluation of its quality being returned to the foundry the same day it is poured.

Whenever required, chemical analysis is also available. Baldwin's chemical and spectrographic laboratories are closely coordinated. Frequently both tackle the same problem as a safeguard against error.

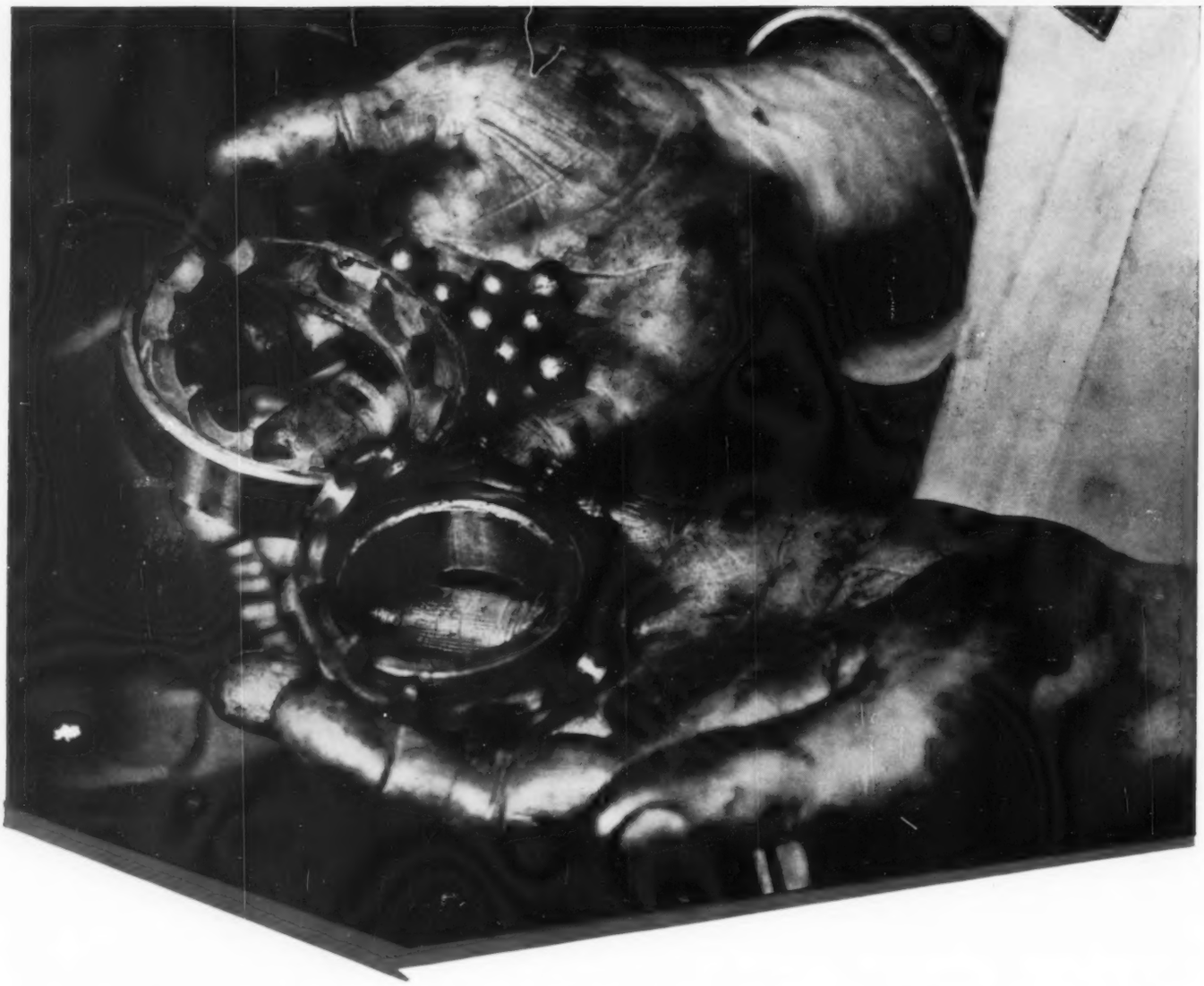
Job shop or high production foundry work, forming alloy castings of multiple composition and weighing from a few ounces to some 50 tons each—whatever the requirements, our extraordinary shop facilities have the means to take them in stride. The quality control exercised by our superbly equipped chemical and physics laboratories assures you of satisfaction. Write today for our illustrated Foundry Bulletin 6002.

BALDWIN · LIMA · HAMILTON

Eddystone Division

Philadelphia 42, Pa.

Hydraulic turbines • Weldments • Dump cars • Nonferrous castings • Special machinery • Bending rolls • Machine tools



When bearings must be replaced . . . "almost the same" is always wrong!

There is a difference in precision, fit-up and clearance of bearings carrying the same part number and Bearings, Inc. experts know which bearing will give you longer service life on any application.

This knowledge, plus the immediate availability of all types of bearings used by industry, guarantees that you get the bearing best for each application! They will be "factory fresh". . . incorporating the latest design and manufacturing advancements.

If in doubt about the proper specifications for a bearing application, contact the Bearings, Inc. engineer in your area — he'll be glad to make recommendations that are right all the way.

Always Buy from an Authorized Distributor.

Providing bearing service in the North →

BEARINGS, INC.

OHIO: Akron • Canton • Cincinnati • Cleveland • Columbus • Dayton • Elyria • Hamilton • Lima • Lockland • Mansfield • Toledo • Youngstown • Zanesville
INDIANA: Ft. Wayne • Indianapolis • Muncie • Terre Haute • **PENNSYLVANIA:** Erie • Johnstown • Philadelphia • Pittsburgh • York
WEST VIRGINIA: Charleston • Huntington • Parkersburg • Wheeling • **NEW JERSEY:** Camden
NEW YORK: Buffalo, Balanrol Corp. • **MARYLAND:** Baltimore • **DELAWARE:** Wilmington

and

in the South →

DIXIE BEARINGS, INC.

FLORIDA: Jacksonville • **GEORGIA:** Atlanta • **KENTUCKY:** Louisville • **LOUISIANA:** Baton Rouge • New Orleans
N. CAROLINA: Charlotte • Greensboro • **S. CAROLINA:** Greenville • **TENNESSEE:** Chattanooga • Kingsport • Knoxville • Nashville

Date-line Diary...

February 3

△ The AISI reports that the operating rate of the steel industry for the week of February 3 is scheduled at 54.0 per cent of capacity. This is equivalent to 1,454,000 tons compared with 1,459,000 tons one week ago and 2,485,000 tons one year ago. Index of production for the week is 90.5.

△ Iron ore consumption in the United States in 1957 rose four per cent over 1956, despite 2.2 per cent drop in steel output.

February 4

△ Auto assemblies for January, 1957 totaled 489,357 cars, 8.5 per cent under the December, 1956 total and 23.7 per cent lower than January, 1956 output.

February 5

△ The AISI reports that the iron and steel industry is planning to spend $1,000,000,000 for additions and improvement of facilities; outlays in 1957 totaled $1,750,000,000 and added about 7,300,000 tons to steelmaking capacity.

△ Steel scrap prices in the San Francisco area dropped $2.00 a ton this month. Price for No. 1 heavy melting scrap is $32 a ton, No. 2 heavy melting and No. 1 bales are both quoted at $30 a ton.

February 6

△ Government figures showed that construction expenditures in January totaled $3,300,000,000, down ten per cent from December, 1957.

△ The Commerce Department reported that manufacturing firms incoming business declined $900,000,000 in December, 1957; manufacturers' inventories fell $300,000,000 in December to a seasonally adjusted total of $53,600,000,000.

△ Major producers reduced prices about one per cent on two grades of stainless sheets and cold-rolled strip.

△ Republic Steel Corp. announced it is temporarily halting steel and iron smelting at the Massillon, Ohio, plant until business conditions improve; open hearth production has been moved to Canton, where two additional open hearths will resume operation; three stainless steel finishing mills and two bar mills at Massillon will continue to operate.

△ Inland Steel Co. announced its board of directors have approved an unemployment benefit plan for 3000 of its nonsupervisory salaried employes. The plan is similar to the one in effect for its production and maintenance workers, which provided unemployment benefits up to 65 per cent of an eligible employee's after tax weekly take home pay for as long as 52 weeks. Minimum service requirement is two years with the company.

△ The AISI reports that the iron and steel industry's payroll for 1957 amounted to $4,001,000,000 compared with $3,795,975,000 in 1956. Estimated total employment was 656,700, compared with 653,400 in 1956. Average hourly payroll cost per wage earner was $2.917, compared with $2.700 in 1956. Average hours worked a week 37.2 in 1957 compared with 38.6 hours in 1956. Estimated payroll in December, 1957 was $299,560,000, compared with $316,263,000 in November, 1957; average hourly payroll cost during December was $3.006, compared with $3.013 during November; total employment in December was 606,200, in November 625,700. Average hours worked a week was 32.9 compared with 36.1 in November.

△ The Bureau of Mines reports that estimated production of Pennsylvania anthracite for January, 1958 equals 2,197,000 net tons, compared with 1,836,000 tons in December, 1957 and 2,639,000 tons in January, 1957.

February 7

△ The AISI reports that shipments of finished steel products for December, 1957 totaled 5,092,913 net tons, compared with 5,606,018 tons in November, and 7,064,093 tons in December, 1956; shipments for 1957 totaled 79,894,577 net tons, compared with 83,241,168 tons in 1956.

February 10

△ Retail deliveries of new cars in January, 1958 dropped to 381,000 units, down 22.6 per cent from December, 1957 and 22.2 per cent below January, 1957; inventories of new cars totaled 825,000 at January 31, 20 per cent above last year. American Motors Corp.'s sales were up 26 per cent; which was offset by declines in sales by Ford Motor's down 30 per cent, Chrysler Corp.'s about 34 per cent; General Motors down 11 per cent.

△ The AISI reports that the operating rate of the steel industry for the week of February 10 is scheduled at 53.7 per cent of capacity. This is equivalent to 1,449,000 tons compared with 1,457,000 tons one week ago and 2,501,000 tons one year ago. Index of production for the week is 90.2.

February 11

△ Eagle-Picher Co. plans to suspend zinc smelting operations at its Henryetta, Okla., plant February 15, idling about 650 employes. Resumption of operations will await pickup in zinc demand.

△ Sulphur companies anticipate 1958 consumption of sulphur in the U. S. to equal the 1957 usage; depending on extent of Mexican sulphur imports. Sulphur output in Mexico in 1957 rose to approximately 1,000,000 tons, from 775,000 in 1956.

△ AISI preliminary reports indicate production of ingot steel in January, 1958 totaled 6,739,000 net tons, compared with 7,420,285 net tons in December, 1957 and 11,008,762 tons in January, 1957. Index of production for January, 1958 was 94.7 compared with 104.3 in December, 1957 and 154.7 in January, 1957. Operating rate for January averaged 56.4 per cent of capacity based on January 1, 1958 rating of 140,742,570 net tons annually.

February 12

△ Katanga reduced price of copper at New York and Antwerp ½¢ per lb, to 20⅞¢, following continued weakness in spot copper in London where quotation dipped ¼¢ to 20.06¢ a lb.

February 13

△ Postmaster General Sommerfield formally presented Congress the Administration's $2,000,000,000

program for modernizing post office buildings, citing that the plan should be tied to a five-cent first-class letter rate.

Δ ICC granted permission to railroads to increase selective freight rates approximately two per cent effective February 15, but refused to allow some proposed changes in operating changes aimed at bolstering revenues.

Δ The Associated General Contractors of America estimate that heavy construction outlays in 1958 will total approximately $68,000,000,000, which would be a four per cent gain over 1957.

February 14

Δ Government figures showed that private housing starts increased in January to a yearly rate of 1,030,000 units, which compares with an average rate of 1,000,000 in the last quarter of 1957.

February 17

Δ Phoenix-Rheinrohr A.G., Duesseldorf, West Germany reported for the fiscal year ended September 30, 1957: sales amounting to $387,857,143, net profit distributed as cash dividend to shareholders of $4,435,000 compared with the September 30, 1956 reported sales of $333,800,000, profit the same as 1957 figure.

Δ The AISI reports that the operating rate of the steel industry for the week of February 17 is scheduled at 1,459,000 tons compared with 1,445,000 tons one week ago (53.5 per cent capacity) and 2,504,000 tons one year ago. Index of production for the week is 90.8.

Δ R. L. Gray, president of Armco Steel Corp., and A. W. McKinney, president of National Supply Co. announced that a joint plan of agreement of merger between the two companies has been executed, and the plan will be submitted to stockholders of both companies at meetings to be held April 16 and 17. Stockholders of National Supply will receive 0.85 share of Armco stock for each share of National Supply.

Δ Steel scrap prices in Chicago declined as much as $2 a ton.

February 19

Δ The Bureau of Mines reported that the consumption of scrap during December, 1957 totaled 4,282,000 gross tons. Pig iron used was 4,513,000 gross tons compared with 4,848,489 tons of scrap and 5,073,898 tons of pig iron in November, 1957.

Δ The Bureau of Mines, U. S. Department of the Interior, reported that production of iron ore in the United States for November, 1957 totaled 4,974,047 long tons; shipments totaled 5,348,379 long tons.

February 20

Δ August Thyssen-Huette launched a 15,000-ton, 350 ft long, 66 ft wide, 30 ft deep, speed 14 knots, motorship this week to transport U. S. coal to its mill in Ruhr Valley. The ship "Fritz Thyssen" is expected to make its maiden voyage in April.

Δ The Aluminum Assn. reported primary aluminum production in the United States during January, 1958 was 139,909 short tons compared with 140,033 short tons in December, 1957 and 147,030 tons in January, 1957.

February 21

Δ The ARCI reports that deliveries of new domestic freight cars in January, 1958 totaled 7219 compared with 6174 in December, 1957 and 8403 in January, 1957. Orders totaled 401 compared with 3492 in December, 1957 and 6304 in January 1957. Backlog of cars on order as of February 1 stood at 48,787 cars compared with 55,941 a month earlier and 114,656 on February 1, 1957.

Δ The Assn. of American Railroads reported that carloadings for the week ending February 15 amounted to 533,237 cars, an increase of 948 cars over one week ago, but down 142,729 cars from the same period in 1957.

Δ General Electric Co. reported for 1957, sales amounting to $4,335,664,061, net income $247,851,871, earnings per share $2.84; compared with 1956 sales $4,090,015,685, net income $213,756,849, earnings per share $2.46.

Δ Regulatory authorities in Texas set permissible output of crude oil at 2,517,259 barrels daily, 513,814 barrels under present legal ceiling.

Δ The Senate Finance Committee approved a House-passed bill providing for $5,000,000,000 increase in the $275,000,000,000 Federal debt limit.

Δ The New York Federal Reserve Bank reported that business loans at principal New York banks increased $152,000,000 in the week ended February 19. Total business loans by banks reporting to the Federal Reserve Bank amounted to $11,245,000,000, a decrease of $455,000,000 since January 1, 1958 but about $89,000,000 more than loans outstanding a year ago.

February 24

Δ U. S. Steel Export Co., export subsidiary of U. S. Steel Corp., announced export price bases cuts for hot and cold rolled carbon sheets, cold rolled strip, galvanized sheets-carbon, long terne sheets and vitrenamel sheets by $2.80 to $6.00 a ton.

Δ Government figures showed that the nation's output of goods and services for 1957 reached $434,400,000,000, an increase of 5 per cent over 1956 dollar volume. The production rate in the fourth quarter of 1957 dropped to $432,600,000,000 annually, down $7,400,000,000 from the third quarter pace.

Δ Permissible production of crude oil in Louisiana was cut 48,140 barrels daily for March.

Δ The AISI reports that the operating rate of the steel industry for the week of February 24 is scheduled at 1,468,000 tons compared with 1,373,000 tons one week ago (50.9 per cent capacity) and 2,456,000 tons one year ago. Index of production for the week is 91.4.

February 26

Δ Government consumer price index in January rose 0.6 per cent to 122.3 per cent of the 1947–49 average, 3½ per cent higher than a year ago, retail food costs increased 1.8 per cent over December, 1957.

Δ UAW asked General Motors, Chrysler Corp., and Caterpillar tractor to favor layoffs of employees instead of short work weeks citing that the workers affected can collect state and supplemental jobless benefits.

Δ Copper sales were made by custom smelters at

STEEL COMPANIES QUARTERLY FINANCIAL REPORTS—ENDING DECEMBER 31, 1957

	Period	1957 Net sales	1957 Net profits	1957 Earnings per share	1956 Net sales	1956 Net profits	1956 Earnings per share
Acme Steel Co.	4th quar.	$ 31,460,614	$ 623,964	$0.25	$ 45,749,000	$ 1,834,000	$0.88
	Year	147,782,632	6,012,882	2.40	134,236,101	7,011,976	3.34
Alan Wood Steel Co.	Year	.....	2,054,000	...	.....	3,096,000	...
Allegheny Ludlum Steel Corp.	4th quar.	.....	1,925,000	...	.....	5,614,000	...
	Year	266,593,541	11,651,851	3.02	285,959,267	15,261,090	4.04
Armco Steel Corp.	Year	776,735,000	55,044,000	4.59	761,800,102	65,593,182	6.03
Barium Steel Corp.	Year	.....	3,212,000	0.77	.....	6,560,000	1.85
Bethlehem Steel Corp.	4th quar.	601,680,125	47,273,306	1.02	667,184,493	61,721,468	1.35
	Year	2,603,713,277	191,025,933	4.13	2,326,705,414	161,411,625	3.47
Carpenter Steel Co.	4th quar.	.....	842,830	0.94	.....	1,742,024	2.04
Colorado Fuel and Iron Corp.	4th quar.	.....	2,036,628	0.56	.....	3,646,170	1.04
	Year	.....	14,236,851	4.04	.....	12,727,529	3.58
Continental Steel Corp.	Year	.....	2,756,655	5.34	.....	2,793,574	5.41
Copperweld Steel Co.	Year	121,059,207	2,769,855	2.41	129,547,531	4,106,039	3.72
Crucible Steel Co. of America	Year	235,938,306	6,543,594	1.73	263,922,898	12,767,625	3.51
Detroit Steel Corp.	Year	82,458,616	3,004,382	0.90	123,359,756	8,747,092	2.78
Eastern Stainless Steel Corp.	Year	47,336,093	1,831,952	2.74	49,781,798	2,250,944	3.37
Firth Sterling, Inc.	Year	26,529,442	656,446	0.44	27,627,631	763,381	0.66
Granite City Steel Corp.	Year	123,763,000	9,984,000	4.64	137,131,000	15,109,000	7.05
Inland Steel Co.	4th quar.	172,600,000	15,730,247	2.74	.....	.....	...
	Year	772,380,683	58,876,875	10.34	731,767,967	52,998,726	9.43
Jones & Laughlin Steel Corp.	4th quar.	186,740,000	7,482,000	0.91	204,695,000	12,853,000	1.60
	Year	837,568,000	45,452,000	5.65	742,642,000	45,122,000	5.61
Kaiser Steel Corp.	4th quar.	44,367,220	3,085,000	0.78	44,339,890	4,960,000	1.35
	Year	208,619,403	21,438,507	5.91	201,692,305	23,571,852	6.57
Keystone Steel & Wire Co.	4th quar.	22,542,857	1,196,804	0.64	26,314,493	1,821,740	0.97
	6 mos.	43,273,992	2,342,059	1.25	50,499,723	3,549,455	1.89
Laclede Steel Co.	Year	62,226,543	3,838,646	18.61	66,509,030	4,086,071	19.81
Lukens Steel Co.	4th quar.	38,978,822	1,810,197	1.89	37,474,304	3,242,592	3.40
	Year	130,473,207	10,119,998	10.60	105,173,925	7,504,889	7.87
McLouth Steel Corp.	Year	.....	9,410,000	...	.....	8,806,000	...
National Steel Corp.	4th quar.	147,901,847	11,368,963	1.53	183,265,707	17,026,363	2.29
	Year	640,967,342	45,518,884	6.13	664,251,090	52,502,422	7.09
Pittsburgh Coke & Chemical Co.	Year	54,111,000	6,872,000	5.64*	59,678,000	3,921,000	3.03
Pittsburgh Steel Co.	Year	182,000,000	4,155,000	1.80	178,275,000	6,225,000	3.10
Republic Steel Corp.	4th quar.	266,211,433	11,975,228	0.77	365,725,386	34,568,265	2.22
	Year	1,234,483,714	85,014,422	5.45	1,251,628,903	90,406,665	5.83
Sharon Steel Corp.	Year	151,651,824	4,046,773	3.68	180,044,408	6,905,530	6.28
United States Steel Corp.	4th quar.	1,034,243,514	90,096,731	1.56	1,194,587,925	104,528,893	1.83
	Year	4,413,824,226	419,073,722	7.33	4,228,877,241	348,098,916	6.01
Wheeling Steel Corp.	4th quar.	51,673,000	2,971,000	1.32	71,555,000	5,748,000	2.70
	Year	249,756,000	12,078,000	5.32	259,555,000	17,672,000	8.20
Youngstown Sheet and Tube Co.	4th quar.	146,500,000	10,600,000	3.12	170,300,000	18,200,000	5.35
	Year	688,245,862	42,508,579	12.35	684,041,021	43,174,587	12.62

* Includes profit from sale of subsidiary's assets.

23 1/8¢ a lb, down 3/8¢; with resultant price 1 7/8¢ below the 25¢ charge of large U. S. producers.

Δ Shipments of iron and steel castings during December, 1957 amounted to 1,045,438 short tons compared with 1,135,157 short tons in November, 1957 and 1,334,070 short tons in December, 1956.

February 27

Δ AISC reported shipments of fabricated structural steel during January 1958 were 316,742 tons, compared with 290,076 tons in January 1957. Bookings totalled 162,158 tons compared with 320,408 tons in January 1957. Backlog at end of January was 2,778,000 tons.

Δ Scrap dropped $3.00 a ton in the Chicago district with No. 1 down to $37 a ton.

Δ Price of copper by custom smelters dropped 1/8¢ to 23¢ a lb.

Δ Mesta Machine Co. reported net income in 1957 of $6,454,076 or $6.45 a share compared with $4,364,727 or $4.36 a share in 1956.

February 28

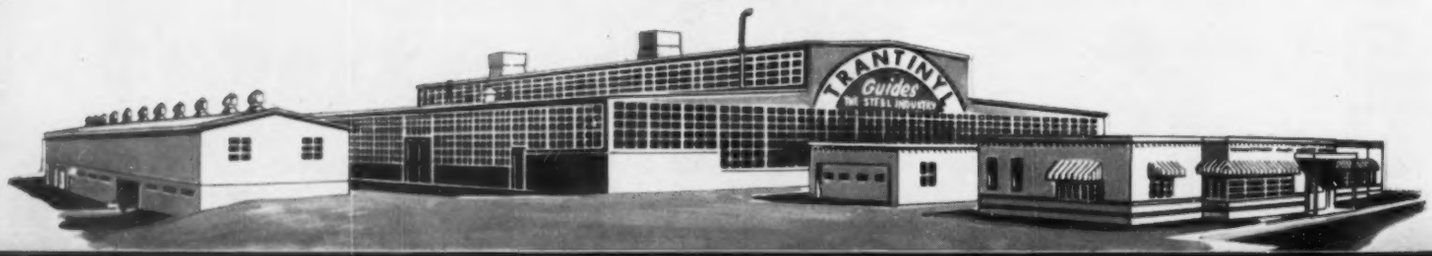
Δ The Agriculture Department reported net cash income of farmers in 1957 fell to $11,500,000,000 compared with $12,100,000,000 in 1956.

Δ A Senate Antitrust subcommittee charged the steel price boosts of $6 a ton last July "substantially exceeded" the rise in the industry's costs and called on the Justice Department and the FTC to determine whether steel producers' pricing practices violate the antitrust laws.

Δ House-Senate Economic Committee has urged cheaper credit and public works spending to halt the business recession.

TRANTINYL

guides the steel industry



YOUNGSTOWN ALLOY CASTING CORP., • YOUNGSTOWN, O.

ROLLING MILLS: bar, hoop, strip, shape mill guides, and rollers. SEAMLESS TUBE MILLS: guide shoes, rolling mill plugs and rolls, piercer points, etc. ELECTRIC WELD TUBE MILL: forming rolls, planishing rolls, tool holders, etc. • STRAIGHTENING MACHINE GUIDES • HEAT RESISTING CASTINGS

Designed by Experience

Heavy-Duty, Cam-Operated

PUSH-BUTTON STATIONS

600 Volts A-C or D-C

● The Euclid Electric & Mfg. Co. (Madison, Ohio) has added a complete new line of Pendant Push-Button Stations for all applications that necessitate NEMA Types 3, 4, 5 or 12 enclosures to meet weather-resistant, water-tight, dust-tight and JIC requirements. Designed for heavy-duty applications, these cam-operated Stations are rated 600 volts, a-c or d-c. They are available from one to five speed-points in each direction for a total of eight circuits to provide for practically an unlimited number of different sequences of operation.

Sturdily constructed to withstand hard usage and abuse, their small cross-section permits comfortable, non-fatiguing, one-hand operation. The extruded aluminum case has cast-aluminum side-plates that can be removed easily for inspection of the silver-to-silver contacts without disturbing any wiring. The threaded conduit fitting is an integral part of the top end-cap which also has welded to it a double-suspension cable hanger.

Extra features include heavy-duty, control-circuit toggle disconnects, pilot lights, selector switches, and maintained-type contacts.

ASK FOR BULLETIN 2016

Also Available in Explosion-Proof Types.

THE EUCLID ELECTRIC & MFG. CO.
MADISON, OHIO

THE EUCLID ELECTRIC
EUCLID
AND MFG. CO., MADISON, O.

"No secondary cleaner required with a P-A Washer"

...says FURNACE SUPERINTENDENT

This economical feature of the Pease-Anthony washer is only one of the many reasons why P-A is first choice with blast furnacemen.

It's a "natural" where high top pressures are used . . . puts full top pressure to work cleaning gas . . . low water consumption . . . low initial cost with minimum maintenance requirements . . . compact design requires little space.

Units available for capacities ranging up to 150,000 SCFM. Write for descriptive bulletin.

Performance summary of some P-A Washers now in use:

Installation	Years Operated	Volume SCFM	Pressure Drop Inches Water	Dust Loading Grains/SCF	
				Inlet	Outlet
A	4	78,000	30	3-19.0	.01-.04
B	3½	78,000	30	2-3	.02-.08
C	3	85,000	30-40	2-3	.01-.03
D	3	45,000	30	2	.02-.03
E	½	75,000	50	—	.02
F*	½	26,000	12	5	.10
G*	½	26,000	12	5	.10
H	½	90,000	29	—	.04

Installation C is in Illinois. Installation H is in Texas.
All others are in Pennsylvania.

*Two units in parallel on one furnace. Lower efficiency due to lower available top pressure.

CHEMICO

P-A GAS SCRUBBERS

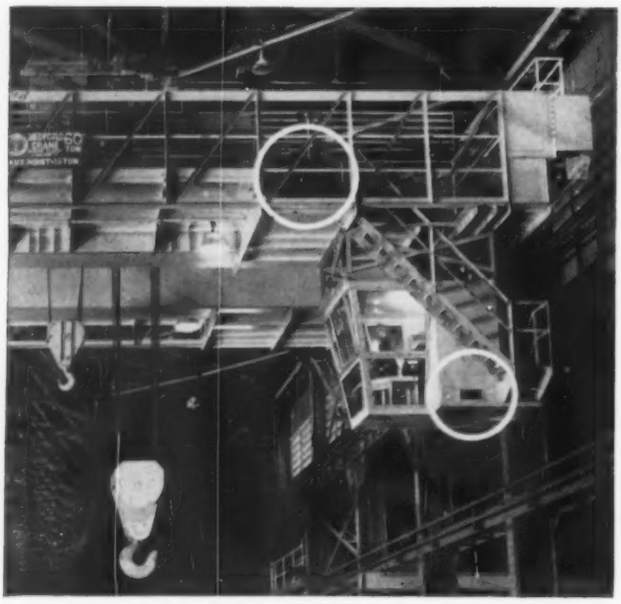
CHEMICAL CONSTRUCTION CORPORATION

A Subsidiary of Electric Bond and Share Company

525 West 43rd Street, New York 36, New York
Telephone LOngacre 4-9400

Technical Representatives Throughout The World
Cable Address: CHEMICONST, N. Y.

CHEMICO CHEMICAL CONSTRUCTION CORPORATION



How LINTERN AIRE-RECTIFIERS Give Greater Value

MORE IN USE. Over 2000 Aire-Rectifiers are in daily use on practically every type of crane and pulpit operation in steel, aluminum, copper and other industrial plants, wherever excessive heat, dust, gas and fume conditions are prevalent.

MORE EXCLUSIVE FEATURES — assuring exceptional performance, long life, low maintenance. Space prohibits listing here. Ask us and we'll send you the list.

EASIEST TO INSTALL. The physical dimensions of Lintern Aire-Rectifiers are the smallest available, yet the capacity is greatest in comparable models.

EASIEST TO SERVICE. All Aire-Rectifiers are so designed that the serviceman can service them in the least possible time. An important feature in providing dependable operation.

* * *

The quality built in is particularly appreciated in the years following installation as it is reflected in ample capacity and low maintenance requirements. For when all factors are considered, the initial price of Lintern Aire-Rectifiers represents utmost value. They actually repay their cost by their savings.

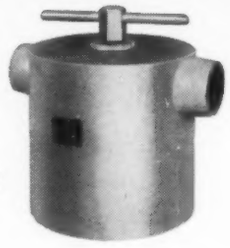
Larco, inc.
DISTRIBUTORS OF LINTERN CORPORATION PRODUCTS
ROUTE 20, EAST • PAINESVILLE, OHIO

There's No Substitute for CLEAN OIL

Avoid the costly damage that dirty oil does to bearings, gears, pumps and other surfaces subject to wear. Keep your lubricating oil clean . . . free from abrasive ferrous particles and cut down maintenance and replacement costs with

FERRO FILTER®

PERMANENT MAGNET SEPARATORS

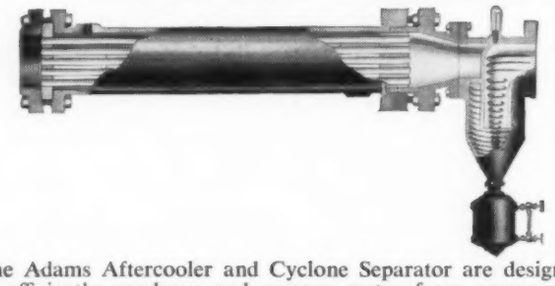


For full information, write for BULLETIN PM-44

S. G. FRANTZ CO., INC.
Brunswick Pike & Kline Ave.
P.O. Box 1138 Trenton 6, N. J.

FERROFILTERS for 1½" to 3" pipe made this way. Other models from ¾" to 8" also available.

Aftercooler and Cyclone Separator designed for cleaner, dryer compressed air



The Adams Aftercooler and Cyclone Separator are designed to efficiently condense and remove water from compressed air and process gas. Condensed moisture and entrained dirt and oil are subsequently removed in a cyclone type separator. This unit is scientifically designed for maximum removal efficiency over a wide range of flow rates.

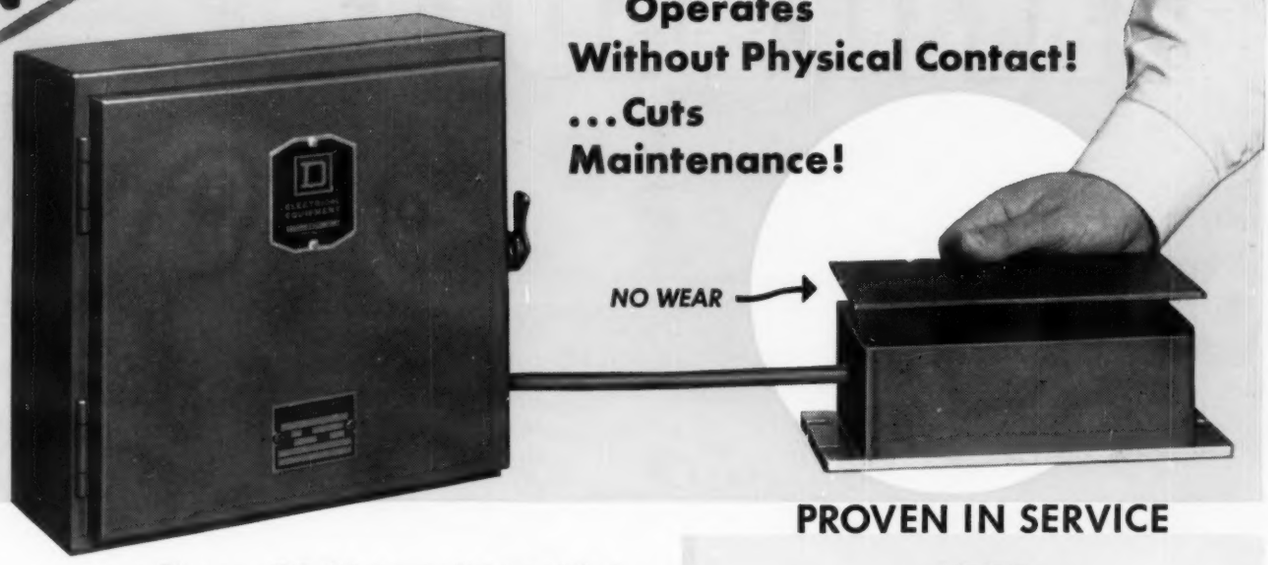
For normal use, units are available to cool gases to within 10° F of the temperature of the cooling water. Specially designed units are available to permit a 2° F approach to cooling water temperature, for application where low moisture content is critical.

Adams Aftercoolers and Separators are available from stock to handle 20 - 40,000 cfm with 10° cooling and 25 - 19,200 cfm where it is necessary to cool within 2°F of the cooling water. Special units can be supplied to suit an unlimited range of requirements. In all cases the maximum pressure loss at rated capacities is ½ psi.

This wide range of sizes enables the economical utilization of Adams Aftercoolers and Separators in virtually all industrial application. For further information on how R. P. Adams' units will solve your compressed air problems and save you money, write today for Bulletin 711. R. P. Adams Co., Inc., 223 East Park Drive, Buffalo 17, New York.

New EC&M AIR-GAP LIMIT SWITCH

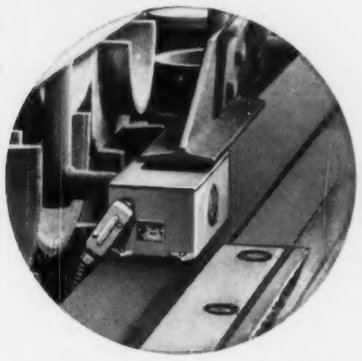
Operates Without Physical Contact! ...Cuts Maintenance!



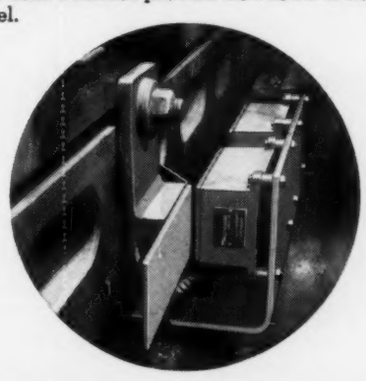
This new EC&M air-gap limit switch is substantially smaller, less costly and easier to apply than the previous design introduced by EC&M in 1948. The standard limit switch may be used on a 110, 220, or 440 volt, 60 cycle outlet. A transformer, self-contained in the relay-enclosure, has taps for quick adaptation for the various voltages. These limit switches are supplied with relays arranged to open or close a circuit.

These air-gap limit switches are ideal for scores of applications. Where engagement-type limit switches are subject to high maintenance and breakage due to impact, these air-gap switches have been giving years of trouble-free operation.

PROVEN IN SERVICE

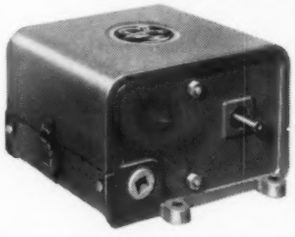


Pipe machine is stopped and reversed as steel operating vane *passes over* stationary reactor. Additional air-gap limit switches provide slowdown at both ends of travel.



Planer has "cut" and "return" reactors mounted on common stationary bracket. Steel operating vane for "return" is adjustable on planer bed. Vane for "cut" also adjustable along planer bed.

NEW EC&M Cam-Type Limit Switch



For reversing and non-reversing applications, these new Bulletin 9008 Type RC Limit Switches save space. This new design is very compact, but retains the advantage of individual cam adjustment without disturbing adjacent cam settings. Roller-operated silver contacts are double-break for high interrupting capacity and long life.

Write for Bulletin 9007-RZ

FOR BASIC STEEL MAKING, IT'S EC&M CONTROL

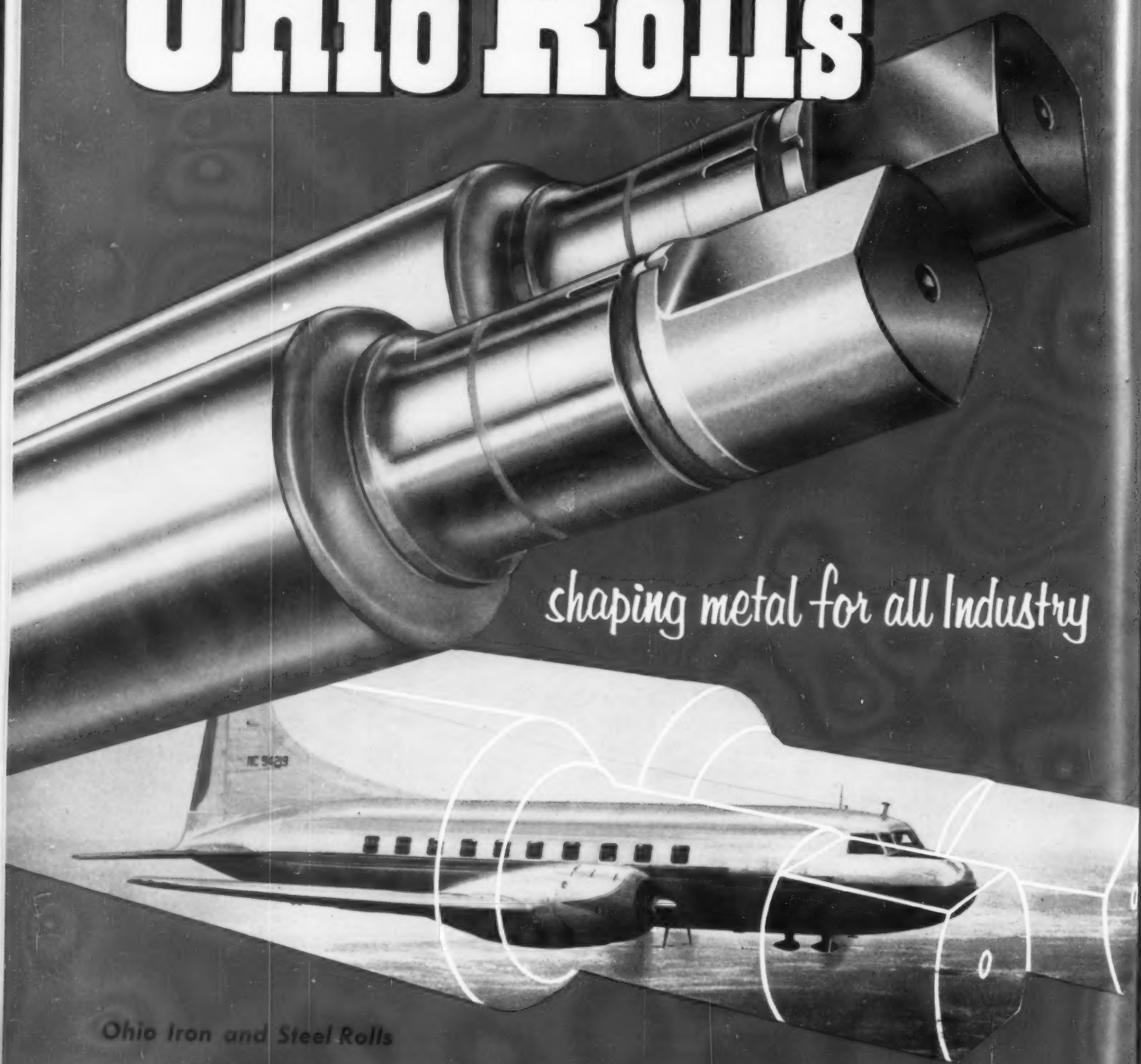
THE ELECTRIC CONTROLLER & MFG. CO.

A DIVISION OF THE SQUARE D COMPANY

CLEVELAND 28 • OHIO

9819

Ohio Rolls



shaping metal for all Industry

Ohio Iron and Steel Rolls

Carbon Steel Rolls
Ohioloy Rolls
Ohioloy "K" Rolls
Flintuff Rolls
Double-Pour Rolls
Chilled Iron Rolls
Denso Iron Rolls
Nickel Grain Rolls
Special Iron Rolls
Nioloy Rolls
Forged Steel Rolls

THE OHIO STEEL FOUNDRY CO.
LIMA, OHIO
Plants at Lima and Springfield, Ohio

LIMA... Virtually at the center of the steel industry

Industry News...

CF&I ADDS NEW DOUBLE COOLING BED AT PUEBLO

△ A double cooling bed has just been added to the rod mill of The Colorado Fuel & Iron Corp. in Pueblo, Colo. The new unit will enable the plant to produce straight bars.

The $\frac{3}{8}$-in. to $\frac{5}{8}$-in. reinforcing bars were previously produced on the 10-in. mill. Production of these bars will be switched to the rod mill, and the 10-in. mill will be completely given over to the production of the heavier sections.

The unit, designed and almost entirely manufactured at the Pueblo plant, consists of a delivery table, a 270-ft-long cooling bed, a cut-to-length table and a crane runway. In addition there are two sets of shears —one set of hot flying shears located ahead of the bed, and one set of cold finishing shears located on the delivery side of the bed.

At a temperature of about 1800 F, the bars travel along the delivery table at an average speed of 1500 fpm. On reaching the cooling beds they are cut to the desired length by an electronically operated shearing mechanism which is set into operation by the radiation of the metal.

Further down, the bars pass another set of electronic devices which cause them to be ejected onto smooth surface cast iron straightening pockets where they slide until stopped by friction and loss of momentum. From there they are picked up by lifting fingers, deposited on escapement racks and lowered onto the shuffle bar section.

Dropped by the shuffle bars onto a runout table, and cut by the cold finishing shears into lengths of 20 to 60 ft, the bars are then pneumatically kicked off into cradles. When the total weight in the cradle reaches 5000 lb a multi-hook crane picks up the load and deposits it into one of the 40,000 lb-capacity bolsters located under the crane runway. From there the load is hauled by a carrier to storage and shipping warehouses where it is unloaded with conventional overhead cranes.

COINS JOIN COKE AT CLAIRTON'S NO. 12 BATTERY

No. 12 battery of Clairton Works, the 20th battery rebuilt at the plant since World War II, pushes its first coke. With Nos. 10 and 11 batteries going into production in 1957, only three of the plant's original 23 batteries are left in operation. Each of the new ovens, constructed by the Allied Chemical & Dye Corp., Wilputte Coke Oven Div., measures 37 ft long, 12 ft high and 19 in. wide. Of the gun-flue type, the batteries have double collector mains for gas and coal chemical recovery. Equipped with self-sealing doors, the ovens will be served by a new quenching station and screening facilities. Observing a Clairton tradition for continued success of a coke battery, Robert Bright, superintendent, coke dept., "Ozzie" Evans, general heater, and D. C. Coleman, Wilputte Coke Div., toss silver coins into the first batch of coke.

NEW PILOT PLANT WILL TEST SMELTING PROCESS

△ An experimental pilot plant will be constructed at Inland Steel Co.'s Indiana Harbor, Indiana works, for the smelting of iron ore by a new process, according to an announcement made by Hjalmar W. Johnson, vice president in charge of steel manufacturing.

The new technique has been developed in the company's research laboratories over the last several years, Mr. Johnson said.

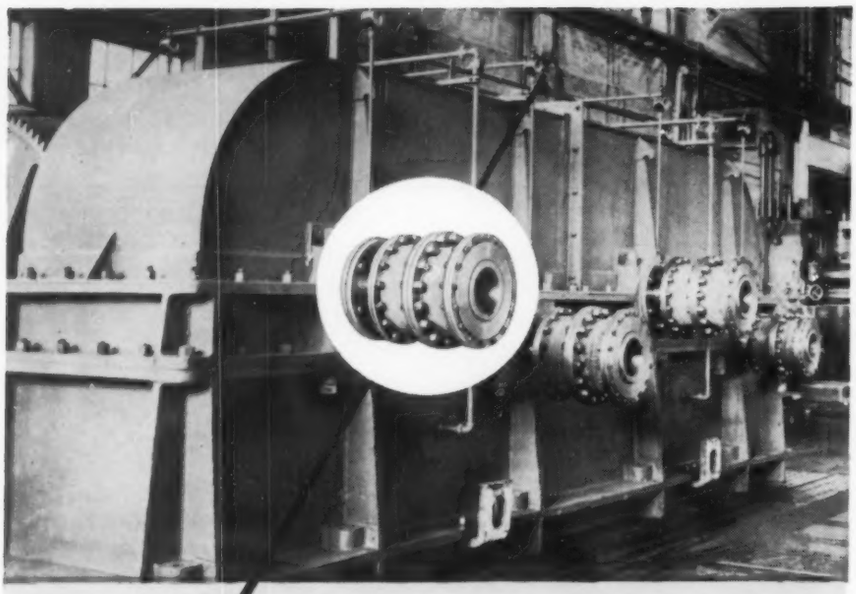
He declined to disclose the details of the process, explaining that applications for patents are pending.

WESTINGHOUSE AWARDED VENEZUELAN CONTRACT

△ Electrical equipment totaling about $3,000,000 has been ordered from Westinghouse Electric International Co. for three rolling mills in Venezuela's first integrated steel plant.

Sixteen motors totaling 19,300 hp are included in the order for the Orinoco steel mill, now being built near Puerto Ordaz by Innocenti S. G. of Milan, Italy. Westinghouse will supply main drives and controls for a 44-in. reversing blooming mill and a 22-stand rod and merchant bar mill, plus controls for a 31.5-in. reversing billet and rail mill.

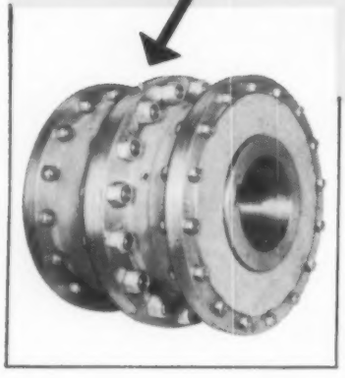
The Orinoco plant will turn out 550,000 tons of finished products annually when it reaches full production in 1960, according to R. D. McManigal, sales vice president of Westinghouse International. About half of this output will go to meet increasing needs of the country's oil industry. Other major products



Waldron heavy duty mill type couplings on rod mill

WALDRON

flexible couplings...



USED IN HUNDREDS OF DIFFERENT APPLICATIONS BUT ALWAYS FOR THE

same 3 reasons

1 **STRENGTH** — Hubs and cover sleeves for sizes 1¼A through 7A are machined from tough steel forgings. Hubs are keyed to the shafts. The two one-piece cover sleeves function as a single, rigid unit serving as a floating connecting link between the hubs. High strength of forgings makes possible a very compact coupling with low rotating inertia.

2 **RELIABILITY** — There are no flexible parts to bend or break and the coupling is dust, moisture, and oil tight. Patented Walflex seal is at the lowest possible diameter where centrifugal force is least. Clearance between teeth in hubs and sleeve is engineered so that an oil wedge always separates them, taking the wear.

3 **SERVICE** — Plenty of rough bore couplings, already assembled—on the shelf for *immediate* delivery. Finish bored standard couplings shipped to meet customers' schedules. We are geared up to give you realistic delivery on *any* type of couplings.

Ask for Catalog 57

JOHN WALDRON CORP.

NEW BRUNSWICK, NEW JERSEY

Representatives In Principal Cities

Export Agents—Frazar & Co., New York, N. Y.

of the plant will be corrugated bars for use in reinforced concrete construction and rails for a projected national railway expansion.

The blooming mill will be designed to reverse from 50-rpm base speed forward to 50 rpm in reverse in 1½ sec or less. The main mill control for the billet and rail mill can switch the unit from 80-rpm base speed forward to 80 rpm in reverse in 1½ sec or less.

Two 4000-hp Westinghouse motors in a twin-motor drive will serve the blooming mill. The three-stand, two-high billet and rail mill with side-by-side stands will be powered by two 6400-hp motors.

REPUBLIC PLANT TO ADD TUBE MILL EQUIPMENT

△ Republic Steel Corp.'s Youngstown plant will spend more than $300,000 for new equipment in its Number 3 electric weld tube mill, it is announced by J. H. Graft, district manager.

An electrically operated mechanical skelp cleaner and two new 16-in. pipe cutoff machines will be installed. The cleaner will cost about $183,000 and the two cutoff machines approximately $159,000.

ALCOA WILL EXPAND CRESSONA FACILITIES

△ Aluminum Co. of America has announced that it will spend more than $500,000 for new facilities at its Cressona, Pa., works, including installation of a vertical impact extrusion press and equipment to produce sheathing for conductor and co-axial cables.

The new installations will diversify the Cressona operation's range of products, formerly restricted to aluminum shapes produced by horizontal extrusion presses.

The hydraulically operated 2500-ton impact extrusion press will produce one-piece, seamless, semi- hollow or solid shapes, having forged bases and one or more extruded side walls. Such parts are used widely by the aircraft, automotive, appliance, electronics and other industries.

The production of aluminum cable sheathing will take place on a 4250-ton extrusion press already in operation at Cressona. New facilities now being installed, include a 1000-

Your NATIONAL TRADE-MARK brush man showed this electroplater how to double brush life!

CLIFF BROWER

Rapid brush wear was limiting generator performance at this busy electroplating plant, says "National" Carbon Brush Man, Cliff Brower. No other industrial brush solved the problem until Cliff suggested a newly developed "National" brush grade.

That was five years ago. Since then not one commutator has been stoned or turned. Brush wear has been even, with no selective action or overheating—even under 20% overloads. This "National" BGX brush grade actually doubled brush life.

Cliff Brower and his fellow "National" Carbon Brush Men have been solving industrial brush problems for years. Their experience and training—backed by "National" *long term brush development*—make them the best consultants on any industrial brush problem.

Call your "National" Brush Man today. Or write National Carbon Company, Division of Union Carbide Corporation, 30 E. 42nd St., New York 17, N. Y.

The terms "National", "N" and Shield Device, and "Union Carbide" are registered trade-marks of Union Carbide Corporation

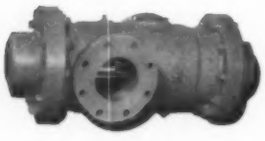
UNION CARBIDE

NATIONAL CARBON COMPANY • Division of Union Carbide Corporation • 30 East 42nd Street, New York 17, N. Y.

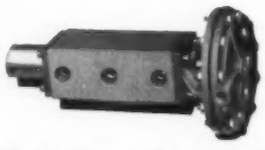
Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco. *In Canada:* Union Carbide Canada Limited, Toronto.

Can **YOU** afford
to overlook the lower costs
increased efficiency and dependability
other plants are getting with

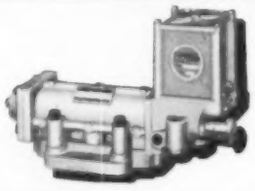
Quick-As-Wink®
AIR AND HYDRAULIC
Control Valves



8" Double Pilot Operated 2-way Valve for Plant Water Systems; Pressures to 250 psi.



½" Diaphragm Operated Single Plunger 4-way Air or Hydraulic Valve; Pressures to 250 psi.



½" Single Solenoid 4-way Air Valve; Pressures to 125 psi; (Conforms to "JIC" Standards).

1" Hand Operated 4-way Hydraulic Valve for Oil or Water Service; Pressures to 2,000 psi.

Quick-As-Wink Control Valves are precision instruments:—unsurpassed for controlling all single or sequence machine movements. They are designed better — and made better — to give users unsurpassed efficiency, economy and satisfaction — free from breakdowns. Serviced easily and quickly — in the field — without disturbing any piping. No need to carry large stand-by inventories — or to return valves to the factory for servicing. Hundreds of different types, sizes and actions, including "JIC" designs. Sizes from ¼" to 4". You'll never know how good they are until you try them . . . *Get full details.*

Write for **BULLETIN NO. 571** *Today.*

Quick-As-Wink®
AIR AND HYDRAULIC
Control Valves

Mfd. by **C. B. HUNT & SON, INC.,** *1926 East Pershing St., Salem, Ohio*
— Engineering and Sales Representatives in the Principal Cities —

ft runout table, water-quench tank and reeling machine.

ARGENTINE CONTRACT AWARDED TO LOFTUS

△ Loftus Engineering Corp., in conjunction with Armco International Corp., general consultants, the government of Argentina, Ferrostaal, A. G. of Essen, Germany, Didier-Werke A.G. of Wiesbaden, Germany and Didier-International GmbH of Wiesbaden, Germany, has recently concluded negotiations for the design, engineering and supervision of erection of extensive facilities to be installed at the General Mamal N. Sonio integrated steel plant currently being built at Punta Agerich, province of Buenos Aires.

The plant, when completed, will be the first integrated steel plant in Argentina and will have a capacity in excess of 600,000 metric tons of ingots per year.

Loftus' contract includes the design and engineering of a complete open hearth shop, with four 225-metric ton open hearth furnaces with waste heat boilers and natural draft stacks; twelve recuperative ingot heating furnaces arranged in six batteries of two holes each with two cover cranes; and one three-zone continuous bloom reheating furnace with metallic recuperator and natural draft stack.

The total cost of the entire steel plant will approach $300,000,000.00 and will have the assistance of banking institutions in Germany, Argentina and the Export-Import Bank of the United States.

PUERTO RICAN STEEL PLANT WILL EXPAND

△ Puerto Rico's first steel mill, Industrial Siderurgica Inc., has received a $120,000 loan for new expansion, the Commonwealth's Economic Development Administration has announced.

Owned jointly by Puerto Ricans and industrialists from Portland, Ore., and Oakland, Calif., the new company launched production of concrete reinforcing steel bars six months ago at a new 80,000 sq ft plant at Cataño, a San Juan suburb. The plant cost $2,250,000.

New expansion will enable the company to supply Puerto Rico's high demand for concrete reinforc-

ing steel bars now estimated at 50,000 tons a year. Put in place construction during fiscal 1957 hit $168,000,000 and should climb higher this year. After launching operations last July, Siderurgica's 1957 production totalled $3,000,000.

The plant employs 155 workers.

J&L ADDS HEAT-TREATING LINE AT DETROIT PLANT

△ A new combination continuous heat-treating and normalizing line has been put into operation at the Stainless Steel Div. plant of Jones & Laughlin Steel Corp., Detroit, Mich.

This installation, which includes two new furnaces, makes it possible to supply stainless steel bars in a close range of hardnesses to meet customers' specifications. The stainless steel grades being treated include Types 403, 410, 416, 431, 420 and 440.

The installation, engineered and installed by The Drever Co., is an extremely compact and versatile unit. Its over-all length is about 100 ft. The line can heat treat stainless steel bars in sizes from ½ in. to 4½ in. diam and lengths up to 30 ft.

After the bars come from the rolling mill they are placed in the hardening furnace. The bars are conveyed through the hardening furnace by a walking beam type hearth and then after the proper time at temperature, are discharged automatically by a roll drive. The bars are unloaded into a bath of quenching oil.

The bars require about 20 to 25 min to cool in the oil. They are lifted out of the bath by a chain conveyor, and then fed into the tempering furnace. The time necessary to temper the bars varies from ½ hr to 4 hr, depending on the size of the bars.

The heat-treating and normalizing line has a rated capacity of about 500 tons per month.

AWARDED CONTRACT FOR TWO INLAND FURNACES

△ A contract for the design and erection of two 4-zone furnaces for Inland Steel Co.'s structural mill at Plant No. 2. Indiana Harbor, Ind., has been awarded to Salem-Brosius, Inc. The furnaces, operating on coke oven gas or fuel oil, will be used for reheating steel blooms preparatory to rolling.

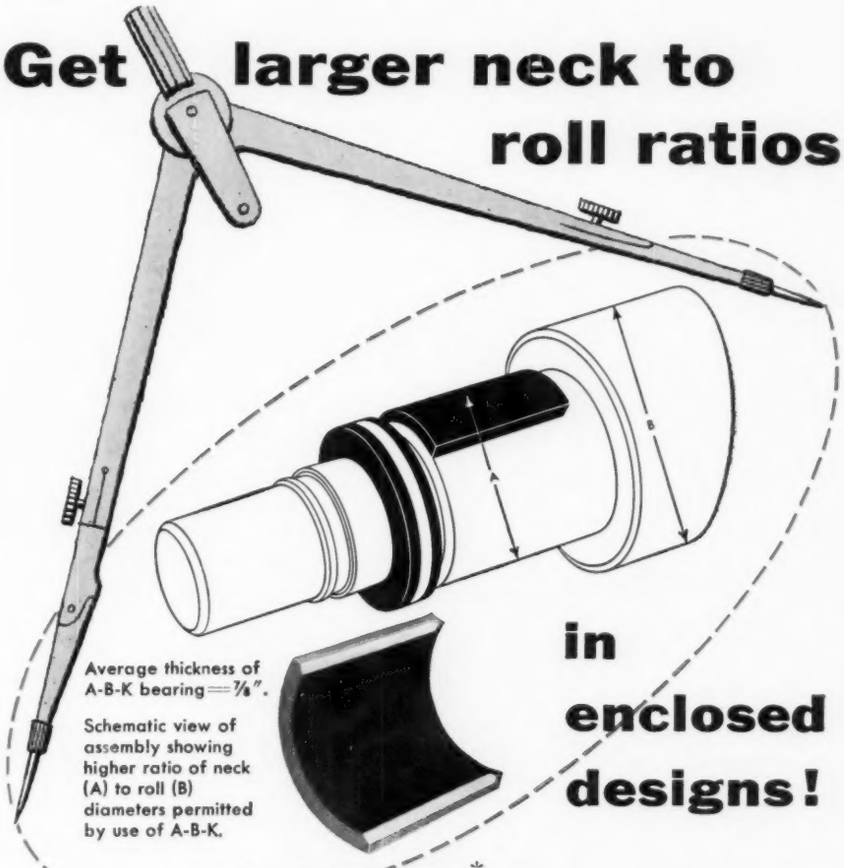
Rated from 75 to 120 tons each per hr, the furnaces will have 72 ft x 24 ft hearths. Recuperation will be included to preheat combustion air to 750 F.

Meetings

△ The Metallurgical Society of the American Institute of Mining, Metallurgical, and Petroleum Engineers has announced the technical program for the 41st Annual National Open Hearth Steel Conference to be held April 14–16 in the Statler Hotel, Cleveland, Ohio. Papers will be presented April 14 and 15 under sponsorship of the National Open Hearth Steel Committee of the Iron and Steel Div. An inspection trip to the Cleveland plant of Republic Steel Corp. on April 16 will conclude the meeting.

△ The American Welding Society will hold its annual meeting and exposition in St. Louis, Mo., April 14 to 18.

Get larger neck to roll ratios in enclosed designs!



Average thickness of A-B-K bearing = 7/8".

Schematic view of assembly showing higher ratio of neck (A) to roll (B) diameters permitted by use of A-B-K.

use A-B-K* bearings

No need to sacrifice roll neck diameters to keep down size and cost of bearing assemblies and housings. A-B-K bearings save space, permit larger, stronger roll necks—with cheaper, lighter weight parts. A-B-K laminated phenolic bearings have ability to absorb and cushion heavier impacts, and often outwear metal, many times. Grease and oil can be used for lubrication but water, alone, is often the answer. Ask our engineers for specific recommendations.

- Wear longer
- Won't score or heat check
- Light in weight
- Cut lubricant costs
- Save power

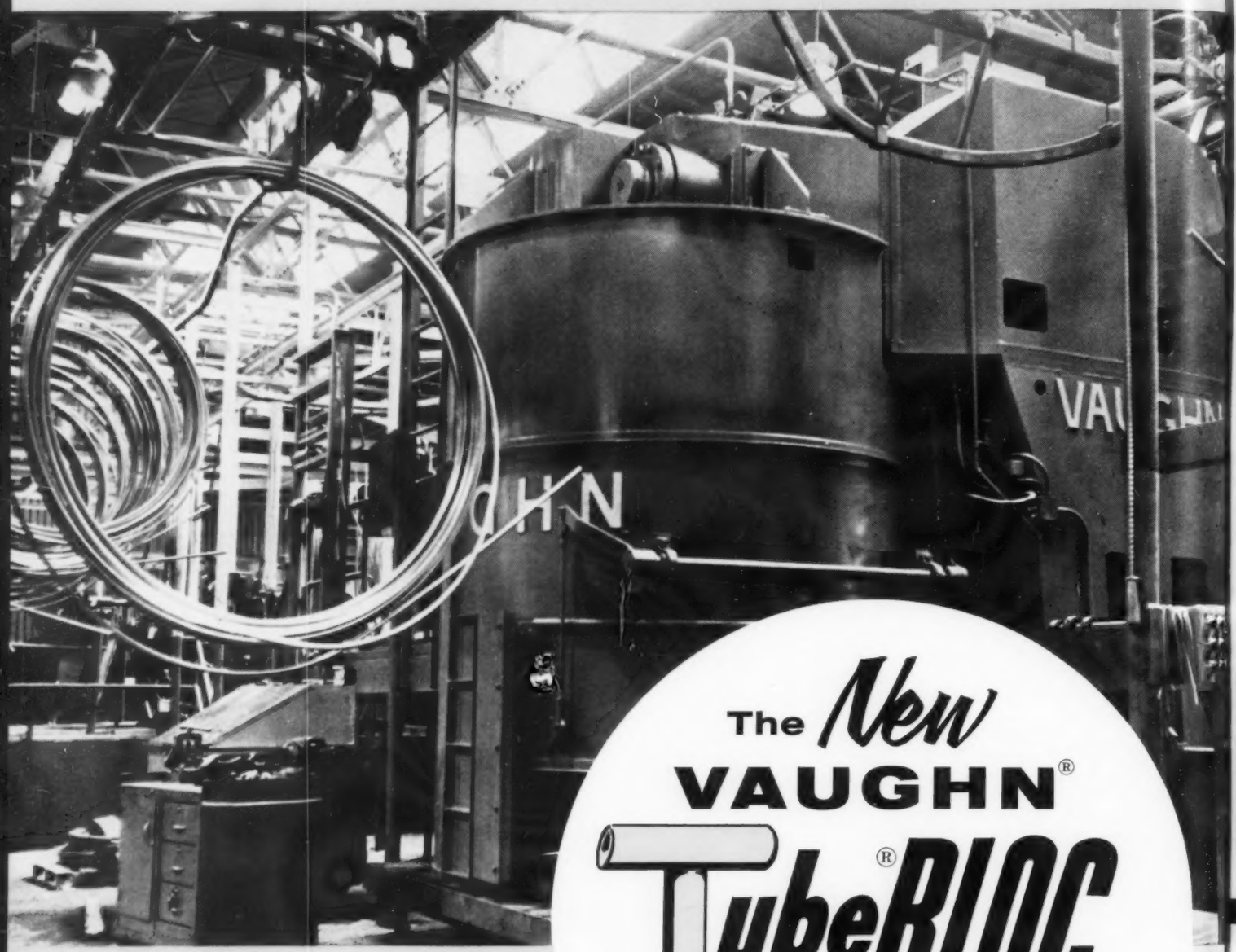
A-B-K
LAMINATED
PHENOLIC BEARINGS

*A registered trade-mark of American Brake Shoe Company in the United States and of Joseph Robb & Company, Limited, in Canada.

American Brake Shoe Company
American Brakeblok Division
DETROIT 9, MICHIGAN

FOR EXTRA LONG LENGTH TUBING IN COILS

AT SPEEDS UP TO 2,000 f.p.m.



The New VAUGHN® TubeBLOC® MACHINE

Finishing 1¼" to ¼" copper tubing

TUBEBLOC—the last word in long-length, thin wall tubing production—is another Vaughn achievement. Shown is the Tubebloc installation for Wolverine Tube Division of Calumet & Hecla, Inc., Detroit, where copper tubing is being produced at speeds up to 2,000 fpm in a finished size range from 1¼" to ¼". The tubing coils are conveyor-handled in a modern set-up matching the efficiency of this great Vaughn machine. Let us give you the newsworthy details!

THE VAUGHN MACHINERY CO.
CUYAHOGA FALLS, OHIO, U. S. A.

"Quick on the Draw!" Ⓥ®

COMPLETE COLD DRAWING EQUIPMENT—Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys

Publication Service...

MARCH, 1958

You Can Obtain . . .

. . . any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

Note: Post cards expire three months after publication date.

(1) Equipment For Steel Industries

Elliott Co. has available a 40-page brochure discussing their products and experience as applied to steel and related industries. More than a hundred photographs and drawings are used. Sections are devoted to drives for steel mill auxiliaries, materials handling equipment, sintering plants, tube mills and hot and cold rolling mills. This includes numerous applications in which Elliott engineered and supplied complete electrical systems from main motor-generators to auxiliary motors and control equipment. (Brochure Q-23A)

(2) Protective Coatings

Released by Rust-Oleum Corp. is a new protective coatings manual. This comprehensive treatise features actual color chips of 102 different coating items and includes complete sections devoted to methods of surface preparation, use of primers, and finish coatings, and the availability of special custom coatings where required. Sections of the new manual include Primers, Short Oil Type Coatings, Long Oil Type Coatings, Restful Color Group, Oil Field Finishes, Heat Resistant and Chemical Resistant Coatings, Galvinoleum Coatings, Floor Coatings and other specialized maintenance products. (Form No. 257)

(3) Metallic Power Rectifiers

Sel-Rex Corp. has published a 32-page guide to metallic power rectifiers utilizing germanium, silicon and selenium semi-conductors. This brochure covers such widely varied applications for rectifier equipment as anodizing, battery chargers, electrocleaning, electroplating, aircraft ground power supplies, current limiting industrial rectifiers, shop power supplies and complete semi-conductor power conversion systems for the operation of electrolytic cells. For each application there is a detailed description, including operational characteristics, of the components used, such as semi-conductor elements, transformers, output regulators, automatic remote controllers, magnetic amplifiers, etc.

(4) Aluminum Air Ducts

A comprehensive book on aluminum air ducts has been published by Reynolds Metals Co. This 130-page book contains 350 illustrations and is ring-bound in a hard, aluminum foil cover. It discusses such subjects as aluminum's advantages for air ducts, recommended alloys and tempers with their properties, prefabricated ducts and details of research recommendations for noise control in ductwork. In addition, the book contains detailed chapters on engineering, drafting, estimating, fabricating and installing aluminum ductwork. Residential, commerical and industrial applications are considered. (File No. 30-D-4:1957)

(5) Coke Quenching Valves

Golden-Anderson Valve Specialty Co. has published a bulletin describing their coke quenching valves. Installation arrangements, parts lists and dimensions are included for both the coke quenching valves and drain valves. Cutaway drawings of both types of valves illustrate the bulletin. (Bulletin W-15)

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 1963, Sec. 34.9, P.L. & R. Pittsburgh, Pa.

IRON & STEEL ENGINEER
1010 EMPIRE BUILDING
PITTSBURGH 22, PA.

IRON & STEEL ENGINEER

Send The *free* Booklets Circled Below:

MARCH, 1958

1	2	3	4	5	50	51	52	53	54	55
56	57	58	59	60	61	62	63	64	65	66
67	68	69	70	71	72	73	74	75	76	77
78	79	80	81	82	83	84	85	86	87	88

NAME _____ TITLE _____

DEPARTMENT _____

COMPANY _____

CO. ADDRESS _____

CITY _____ ZONE _____ STATE _____

* INQUIRIES FOR ITEMS LISTED IN THIS ISSUE NOT VALID AFTER JULY 1, 1958

PUBLICATIONS CURRENTLY OFFERED by Iron and Steel Engineer Advertisers

ITEM	COMPANY	BULLETIN	DESCRIPTION
50	ADAMS CO., INC., R. P.	BULLETIN 711	Aftercoolers and separators
51	AJAX FLEXIBLE COUPLING CO. INC.	CATALOG NO. 64	Dihedral spindle couplings
52	ALLEN-BRADLEY CO.	PUBLICATION 6080	Air break starters
53	AMPCO METAL, INC.	BULLETIN 33	Metals
54	APPLETON ELECTRIC CO.	BULLETIN 504	Reelites
55	ASKANIA REGULATOR CO.		Combustion controls
56	BAILEY METER CO.	PRODUCT SPEC. E65-3	Combustibles analyzer
57	BLISS CO., E. W.	CATALOG 40-A	Rolling mills
58	CAMPBELL MACHINE DIV., AMERICAN CHAIN & CABLE CO.	BULLETIN DH-460-B	Abrasive cutting machines
59	CHANDEYSSON ELECTRIC CO.	D-103	Motor generators
60	CHEMICAL CONSTRUCTION CORP.		Washers
61	CONE-DRIVE GEARS, DIV. MICHIGAN TOOL CO.	CATALOG 57	Gearmotors
62	DELAVAL STEAM TURBINE CO.	BULLETIN 0504	Centrifugal compressors
63	EDDYSTONE DIV., BALDWIN-LIMA-HAMILTON	BULLETIN 6002	Foundry work
64	ELECTRIC CONTROLLER & MFG. CO., THE DIV. SQUARE D CO.	BULLETIN 9007-RZ	Limit switches
65	EUCLID ELECTRIC & MFG. CO., THE	BULLETIN 2016	Push-button stations
66	EXIDE INDUSTRIAL DIV., ELECTRIC STORAGE BATTERY CO.		Industrial truck batteries
67	FARVAL CORP., THE	BULLETIN 26-S	Centralized lubrication
68	FRANTZ CO., INC., S. G.	BULLETIN PM-44	Magnet separators
69	GARLOCK PACKING CO., THE		Oil seals for large shafts
70	HAGAN CHEMICALS & CONTROLS, INC.	BULLETIN MSP-141	Ring balance meter
71	HUNT & SON, INC., C. B.	BULLETIN NO. 571	Control valves
72	KOPPERS CO., INC., FREYN DEPT.		Freyn-Jansen Stove valve
73	LECTROMELT FURNACE DIV., McGRAW-EDISON CO.	CATALOG 10	Lectromelt furnaces and equipment
74	LINK-BELT CO.	BOOK 2416	Belt conveyors idlers
75	OKONITE CO., THE	BULLETIN IS-451	Flexible cables
76	PANGBORN CORP.	BULLETIN 227	Blast cleaning and dust control equipment
77	POST GLOVER ELECTRIC CO.		Resistors
78	REPUBLIC FLOW METERS CO.	BULLETIN NO. 806	Measuring instruments
79	SEL-REX CORP.		Metallic power rectifiers
80	SPRAYING SYSTEMS CO.	CATALOG NO. 24	Industrial spray nozzles
81	SQUARE D CO.		Magnetic starters
82	SYNTRON CO.		Shaker conveyors
83	TAYLOR CHAIN CO., INC., S. G.	BULLETIN 13	Alloy steel chains
84	TAYLOR INSTRUMENT COS.	CATALOG 98262	Potentiometer transmitter
85	UNITED STATES GRAPHITE CO., THE	CATALOG B-56	Brushes
86	WALDRON CORP., JOHN	CATALOG 57	Flexible couplings
87	WATERBURY FARREL FOUNDRY & MACHINE CO., THE	CIR. NO. 731-R	Wire flattening mills
88	YODER CO., THE		Tube mills

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 1965, Sec. 34.9, P.L. & R. Pittsburgh, Pa.

IRON & STEEL ENGINEER
1010 EMPIRE BUILDING
PITTSBURGH 22, PA.

IRON & STEEL ENGINEER

Send The free Booklets Circled Below:

MARCH, 1958

1	2	3	4	5	50	51	52	53	54	55
56	57	58	59	60	61	62	63	64	65	66
67	68	69	70	71	72	73	74	75	76	77
78	79	80	81	82	83	84	85	86	87	88

NAME _____ TITLE _____

DEPARTMENT _____

COMPANY _____

CO. ADDRESS _____

CITY _____ ZONE _____ STATE _____

* INQUIRIES FOR ITEMS LISTED IN THIS ISSUE NOT VALID AFTER JULY 1, 1958

1908
THE FIRST installation of Koppers Coke Ovens in North America, at Joliet, Illinois. The 280 ovens had a daily capacity of 2,240 tons of coke.
1958
TODAY, in addition to coke-oven leadership, Koppers offers proven experience in the execution of contracts involving every phase of steel-making processes.

KOPPERS

50 YEARS OF SERVICE TO THE STEEL INDUSTRY

ON JULY 27, 1908, the first American battery of Koppers by-product coke ovens was fired at the Joliet Works of the old Illinois Steel Company. Since that time, leadership in research and coke-oven technology has established Koppers as the world's leading designer and builder of coke ovens and related equipment.

In North and South America alone, Koppers has built 19,381 coke ovens—equivalent to a battery of 32 ovens *every month* since 1908. Right now, Koppers Coke Plant Department has under construction twelve more batteries, with 552 coke ovens.

Through the years, Koppers has broadened its activities to include the design, construction and start-up of most types of steel-plant installations. The Engineering and Construction Division has proved its ability, in thousands of contracts, to solve practically any construction problem encountered in the steel industry.

On the next few pages, you will find highlighted some of the Koppers services which can expedite your expansion or rebuilding plans.

ENGINEERING AND CONSTRUCTION DIVISION

COKE PLANT DEPARTMENT

FREYN DEPARTMENT

CHEMICAL DEPARTMENT

YEARS OF ENGINEERING AND CONSTRUCTION SERVICE

1908···1958

HOW KOPPERS SERVES THE STEEL INDUSTRY

19,381 COKE OVENS. Fifty years ago, Koppers Coke Ovens became the standard by which other coke ovens were judged. Ovens built by Koppers remain in first position today . . . because of improvements such as oven walls made of Hammerhead brick, waste-gas recirculation, precise control of combustion, and design that permits efficient heating with coke-oven, blast-furnace or other lean gases.

Koppers has designed and built 19,381 chemical-recovery coke ovens in the Western Hemisphere alone. Many thousands more have been installed in other parts of the world.

COAL-CHEMICAL RECOVERY. The dephenolizing plant shown at the left is one of four such plants designed and constructed by Koppers. Installed at a large Midwestern steel plant, it is capable of removing 98% or more of the phenols from crude ammonia liquor.

The Coke Plant Department of Koppers is skilled and experienced in all problems associated with coke-plant design, construction and operation. Koppers engineers can help you with the planning, installation, and operation of coal and coke preparation and handling systems, coal-chemical recovery plants, and all other coke-plant equipment.

TODAY

ANY JOB...ANYWHERE... WELL DONE

Koppers and its Freyn Department have the proven ability to handle the engineering and construction work involved in all phases of steelmaking.

Koppers personnel have *actual experience*, around the world, in the design and installation of blast furnaces, ore-handling facilities, sintering plants, open-hearth shops, rolling mills, continuous-casting units, electric-furnace shops, mold foundries, and other equipment.

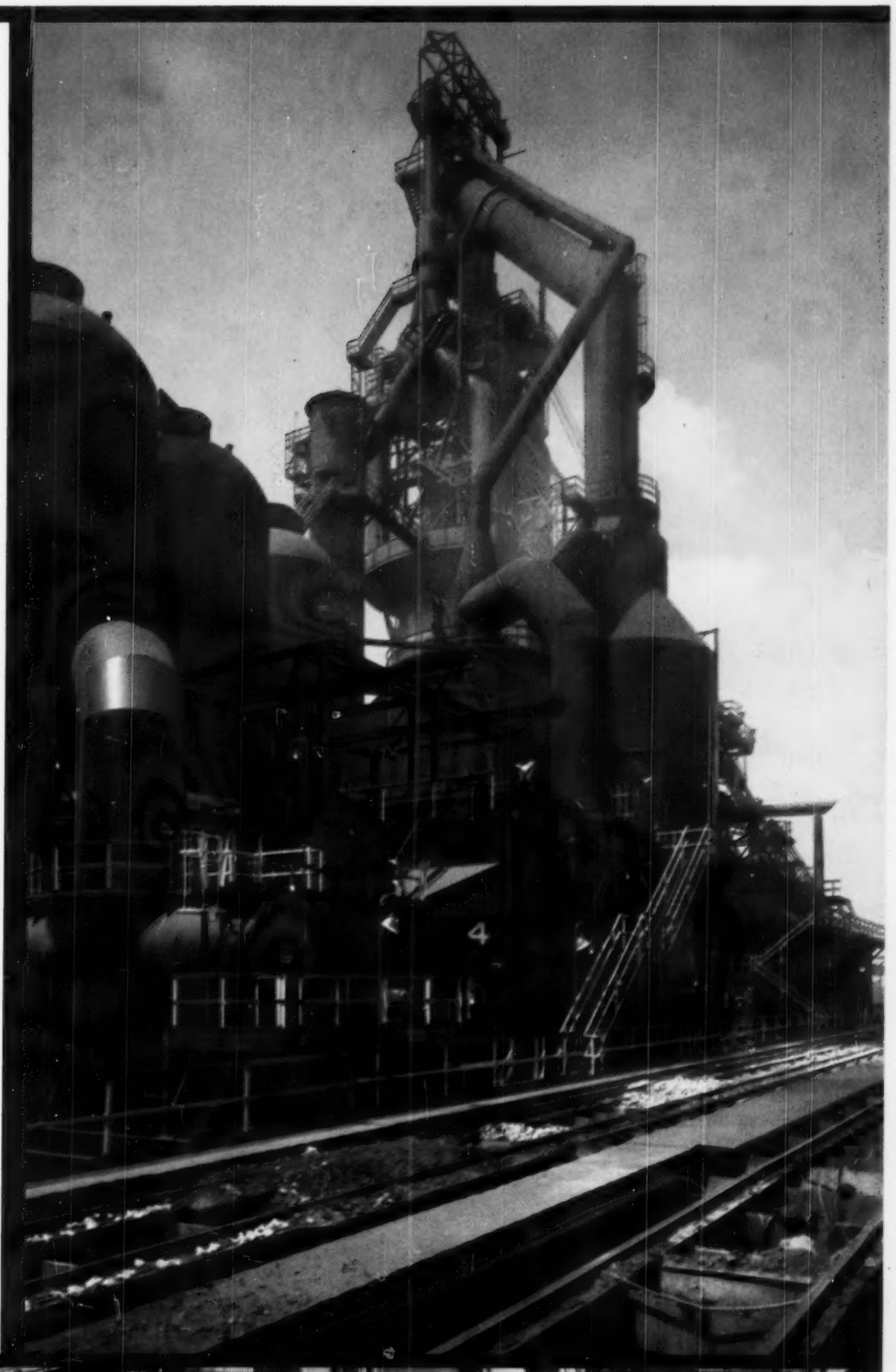
96 BLAST FURNACES, by Freyn and foreign associates, are currently in operation throughout the world. The furnaces have a total annual capacity of more than 27 million net tons.

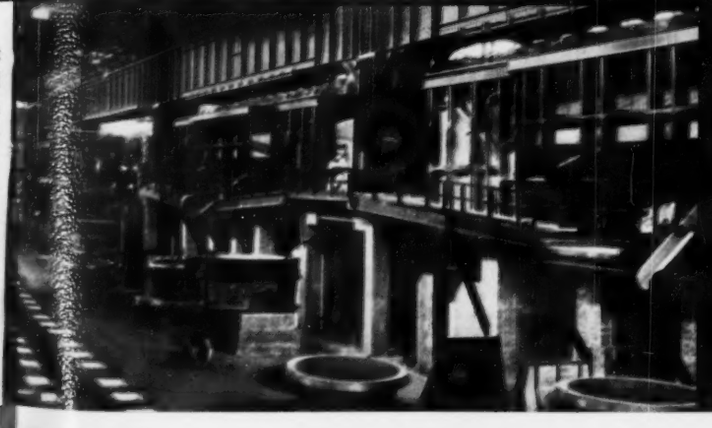
91 SINTERING MACHINES, designed by Koppers American Ore Reclamation Section (AORCO), are in active service in eight countries. Total annual capacity of these machines is over 32 million net tons. Sixteen more AORCO machines with a total annual capacity of over 14 million tons are currently on order and will be completed by 1959. Koppers is now installing two 12-foot-wide sintering machines, both of which will be larger than any now in operation.

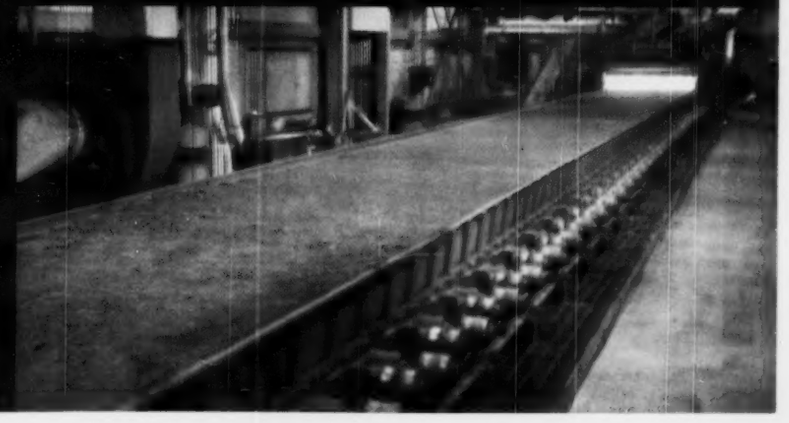
76 OPEN-HEARTH FURNACES have been designed and engineered by the Freyn Department since 1942. Forty-one of these installations are in the United States, including seven 350-ton furnaces completed recently for a large Eastern steel plant.

CONTINUOUS CASTING OF STEEL was pioneered in North America by Koppers. The first commercial-scale installation on this continent was designed and constructed in 1954 by the Freyn Department.

Freyn-Design assures you that the men handling your construction work understand the steel industry and its problems . . . and have the ability and experience needed to tailor an installation to your special requirements.







FROM KOPPERS . . .

CHEMICAL PLANTS

TOO !

Experience—Koppers has a wide variety of experience in the design and installation of chemical plants. Engineers of the Chemical Department have built plants to distill tar . . . to reform gas . . . and to produce styrene monomer, polystyrene, polyethylene, ammonia, and a variety of other chemicals.

Recently the Chemical Department has completed a new coke-oven light-oil purification plant based on hydrogenation to remove sulfur and other compounds. It is the largest such unit in the world. Koppers also has made available to the steel industry a new process for the *recovery and regeneration* of waste acid in steel-pickling operations.

WHAT does it all mean TO YOU?

The three departments of Koppers Engineering and Construction Division bring you a unique combination of experience and service.

They bring you actual proof of performance in the planning, construction and operation of nearly every type of steel-plant installation.

They bring you a rich background of operating know-how in metallurgical, coke, and chemical plants, gained through Koppers own production experience.

They bring you the vast staff resources available only from a large and diversified company such as Koppers. They can call on experts to assist you in market research and development . . . and in purchasing and other problems.

In addition, they bring to steelmakers the results of constant exploration of new techniques and processes evolving from continuous research and development.

Investigate Koppers and its ability to serve you.

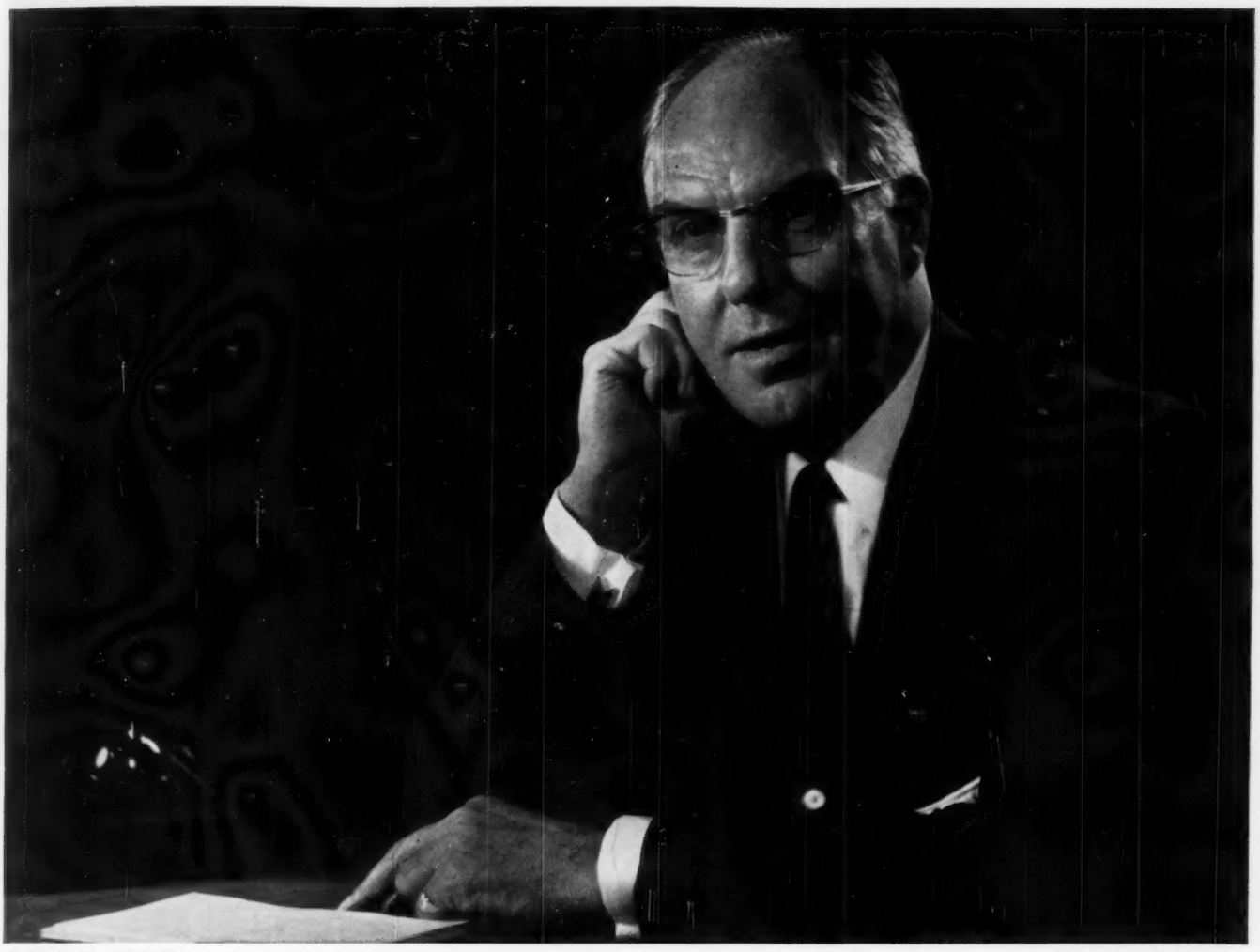
YEARS OF ENGINEERING AND CONSTRUCTION SERVICE

1908 · · · 1958

KOPPERS

KOPPERS

ENGINEERING AND CONSTRUCTIO



G. ALLAN MacNAMARA

Portrait by Fabian Bachrach

"IT'S AGAIN FASHIONABLE TO BE THRIFTY— and 69% of our Soo Line employees are saving regularly through the Payroll Savings Plan"

"It's again fashionable to be thrifty, and it is reassuring to note that 69% of our employees on the Soo Line are making regular purchases of U. S. Savings Bonds. Inflation is a complex thing, but here is a simple, direct step every one of us can take to help control the rising price spiral. Our recent company-wide campaign has proved that employees *want to* and *will* practice thrift by buying U. S. Savings Bonds."

G. ALLAN MacNAMARA, ***President, Soo Line Railroad***

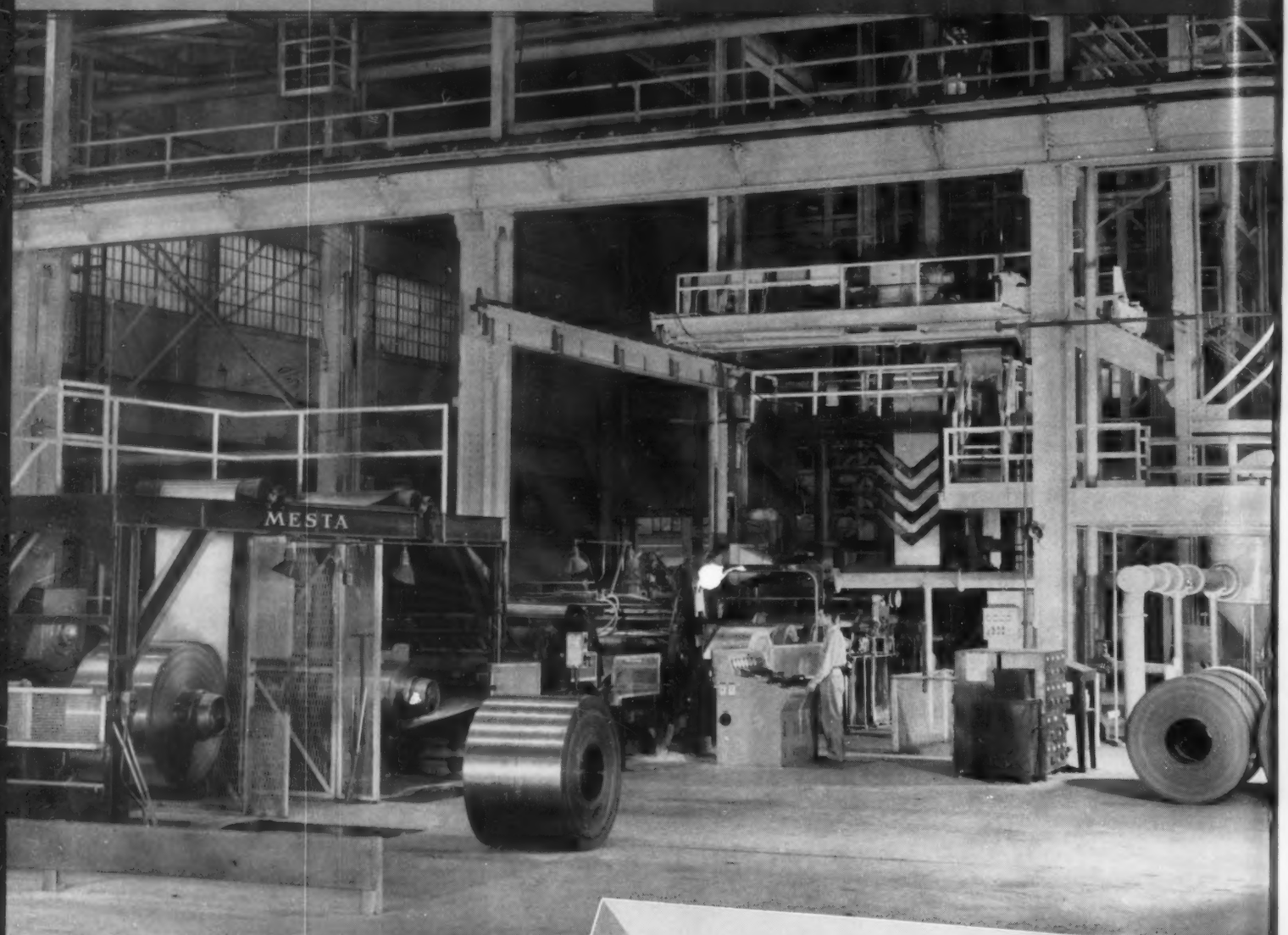
Individual savings are the bedrock of a sound economy. Today there are more Payroll savers than ever before in peacetime. If employee participation in *your* Payroll Savings Plan is less than 50% . . . or if *your* employees do not now have the opportunity to build for their future through the systematic purchase of U. S. Savings Bonds, your State Director will welcome an opportunity to help. His experience is yours, in setting up a Payroll Savings Plan or in building up enrollment in one already existing. Look up your State Director in the phone book. Or write: Savings Bonds Division, U. S. Treasury Dept., Washington, D. C.

IRON AND STEEL ENGINEER

PUBLIC SERVICE ADVERTISING COUNCIL

THE U. S. GOVERNMENT DOES NOT PAY FOR THIS ADVERTISEMENT. THE TREASURY DEPARTMENT THANKS, FOR THEIR PATRIOTISM, THE ADVERTISING COUNCIL AND THE DONOR ABOVE

CONTINUOUS CLEANING *and* ANNEALING LINES



MESTA CONTINUOUS CLEANING AND ANNEALING LINE FOR TIN PLATE WITH PAY-OFF REELS, DOUBLE SEAM WELDER, SHEAR, AND TENSION REEL

Designed and Built by MESTA

Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

Personnel News...

Walter F. Munford, who has been assistant executive vice president—operations United States Steel Corp., becomes executive vice president—engineering and research, and **R. Conrad Cooper,** who has been vice president—administration planning, becomes executive vice president—personnel services. A change in the responsibility of **M. W. Reed,** now executive vice president—engineering and raw materials, to executive vice president—international and raw materials, involves the consolidation of corporation interests in international commercial matters into a new international and raw materials dept. **H. B. Jordan,** who has been executive vice president—operations, becomes executive vice president—production. **George W. Rooney** continues as executive vice president—accounting and **R. F. Sentner** continues as executive vice president—commercial.

Charles H. Williams was named administrative vice president—engineering and **Dr. James B. Austin,** administrative vice president—research and technology, United States Steel Corp. Mr. Williams, who has been assistant executive vice president—engineering and raw materials, heading long range planning for the corporation, will now be responsible for the administration of all U. S. Steel engineering activities. Dr. Austin, who has been vice president—research and technology, will continue to be the administrative head of these departments.

Mr. Williams joined U. S. Steel as a power engineer for National Tube Co. in 1927 after a year with Jones & Laughlin Steel Corp. In 1930, he started at the Ohio Works of Carnegie-Illinois as power and fuel engineer. In 1939, he was appointed assistant chief engineer and in 1940, power, fuel and steam engineer. In 1942, Mr. Williams was appointed assistant to vice president—engineering of United States Steel Corp. of Del. The following year he became chief engineer, Pittsburgh district, of Carnegie-Illinois and in 1948, chief engineer of the corporation. In 1952, he was appointed assistant executive vice president—engineering and raw materials of United States Steel. Mr. Williams is a past president of the Association of Iron and Steel Engineers.

Dr. Austin joined U. S. Steel at the Kearny, N. J., laboratory in 1928. For the first 12 years he was engaged as a physical chemist. He became supervisor of chemistry in 1941 and assistant director of the laboratory in 1944. In 1946, he became director of research. Dr. Austin was appointed assistant vice president—research and technology in 1954. When the Kearny laboratory was moved to U. S. Steel's Research Center in Monroeville, Pa., in 1956, Dr. Austin moved to Pittsburgh. He became vice president—fundamental research on July 1, 1956, and vice president—research and technology in 1957.

John E. Holt has been appointed assistant division superintendent of the Flat Rolled Products Div., Crucible Steel Co. of America. **Nelson G. Bell** has been named superintendent of the 24-in. bar mill, the position formerly held by Mr. Holt. Mr. Holt joined Crucible in 1943, as assistant manager of the D.P.C. dept. at Midland Works. He was named superintendent of the Forge Stock dept. the following December, and since 1956 has been superintendent of the 24-in. bar mill. Before joining Crucible, Mr. Holt was employed by Barium Steel Corp., Phoenixville, Pa. Mr. Bell has been employed by Crucible since 1923, when he joined Midland Works as shear and mill foreman of the No. 1 merchant mill. In 1929 he was appointed assistant general foreman of the No. 1 and No. 2 merchant mills and bar mill, and in 1952 became general foreman. He has been general foreman of the 24-in. bar mill since 1956.

A. E. Reinhard was elected vice president in charge of the Portsmouth, Ohio, plant of Detroit Steel Corp. Mr. Reinhard joined the Portsmouth organization in 1955 as general superintendent. In October, 1957, he was named general manager. Mr. Reinhard has been in the basic steel industry since 1919, when he joined Youngstown Sheet & Tube Co. There he advanced from laborer in the open hearth and blooming mill depts. to superintendent of the open hearth and Bessemer depts. He left Youngstown in 1943, joining Great Lakes Steel Corp., where he became assistant general superintendent in charge of primary steel production in the Ecorse Mill. He came to Detroit Steel in 1950.

W. F. MUNFORD

R. C. COOPER

C. H. WILLIAMS

Dr. J. B. AUSTIN

T. L. NABORS

J. E. JACOBS

F. S. ECKHARDT

R. M. HURD

T. L. Nabors has been appointed chief combustion engineer for the Southern Steel District of Republic Steel Corp. He succeeds **H. T. Watts,** who has retired. Mr. Nabors was formerly assistant chief combustion engineer at Republic's Gadsden, Ala., plant.

John E. Jacobs was appointed general manager of the Lackawanna, N. Y., plant of Bethlehem Steel Co. to succeed **E. F. Martin,** new vice president in charge of steel operations. Mr. Jacobs was assistant general manager since 1950. **Floyd S. Eckhardt,** chief engineer of the plant, was appointed to succeed Mr. Jacobs as an assistant general manager. **Richard M. Hurd,** assistant chief engineer at Lackawanna, was promoted to chief engineer.

Ward M. Troutman, Pittsburgh district sales manager for the General Refractories Co., has been named vice president of the company. His office will remain in Pittsburgh. Mr. Troutman joined General Refractories in 1947 as a member of the Pittsburgh district sales force. He was named assistant district sales manager in 1953 and promoted to district sales manager in 1954. Previously, he was employed in the sales dept. of the Haws Refractories Co. from 1938 until 1947.

J. P. Cullen has been named manager of clamshell bucket sales, Blaw-Knox Equipment Div. Mr. Cullen took over responsibility from **Arnold Hooper,** whose retirement was recently announced. Joining Blaw-Knox in 1938, Mr. Cullen became Eastern manager of clamshell bucket sales with headquarters in New York. He held this position for thirteen years, servicing New York and Philadelphia areas. Transferring to the West Coast Mr. Cullen managed all Blaw-Knox Equipment and Construction Equipment Div. sales for seven years. Prior to joining Blaw-Knox, he was associated with Industrial Brownhoist Corp.

Edgar D. Leon has resigned as president of Gear Grinding Machine Co. He has been president of the firm since 1953. Mr. Leon has been asked by the directors to remain on the board and act as a consultant. **William F. Wilson,** executive vice president and general manager, was named to assume Mr. Leon's executive duties.

James E. Spearman, formerly assistant to the president, has been appointed sales manager and **Paul J. Kunkler** has been named assistant sales manager of The Vaughn Machinery Co. Mr. Spearman has been associated with the company since 1940, serving in various capacities in the purchasing, sales and accounting depts. Mr. Kunkler has been a member of Vaughn's sales dept. since 1950.

William A. Morton has been named president of Loftus Engineering Corp. **James M. Guthrie** has been named executive vice president; **Walter Suydam,** vice president, sales; and **John F. Corcoran,** vice president.

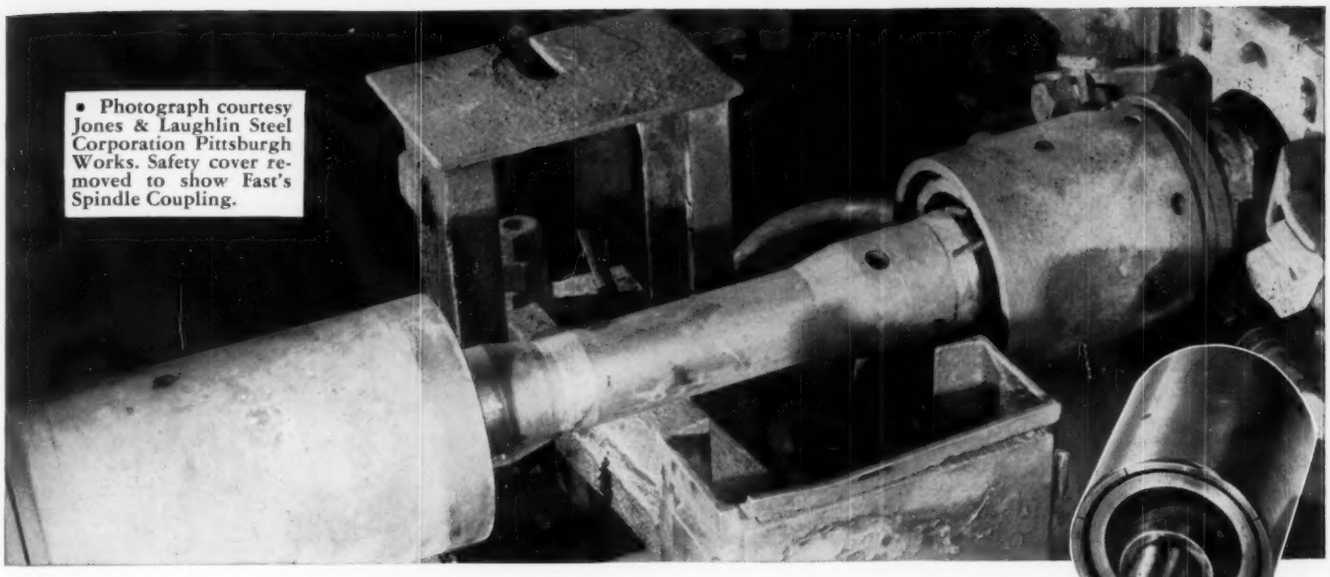
Thomas R. Lally, formerly in the Philadelphia sales office of Basic Inc., has been appointed manager of the Eastern sales district with offices in Pittsburgh, replacing **D. B. Baxter** who has resigned to join Globe Fire Brick Co. **G. W. (Pete) Edwards** has been appointed manager of a newly formed sales district embracing the Detroit, Buffalo-Hamilton and Sharon-Youngstown-Warren areas. In Cleveland, **C. A. Greenlee** has been assigned to sales development under the direction of **J. P. Holt,** with **W. G. Winters** taking over Mr. Greenlee's former duties as sales engineer under **C. R. Heilig,** manager of the Central sales district. **D. M. Flynn** has joined Basic's industrial division, assigned to the Midwest sales district.

Ray E. Over, manager—open hearth dept., M. H. Detrick Co., was elected a vice president. **C. B. Edgar,** Pittsburgh district sales manager, and **Harry E. Lewis,** general manager Insulation Div., were also elected vice presidents.

Dan D. Williams has been appointed assistant general sales manager, and **Curt K. Wiley** Pittsburgh district sales manager, Refractories Div., H. K. Porter Co., Inc. Mr. Williams was previously with E. J. Lavino and Co. in various sales positions since 1950. Mr. Wiley was formerly president of the Gem Clay Forming Co.

L. D. Morton was named general superintendent, Wilputte Coke Oven Div., Allied Chemical & Dye Corp. succeeding the late **Ralph Allingham.** Mr. Morton has been associated with the coke oven industry since 1917. His experience covers the construction of coke plants in the United States, Canada and South America. In addition, he was superintendent of construction on the first modern coke plant in India, 1920 to 1923.

Walter M. Gibbs has been named marketing manager of sheet and plate products for Kaiser Aluminum & Chemical Sales, Inc. Appointed to succeed Mr. Gibbs in Chicago as product manager of sheet and plate is **Joseph E. Griffith, Jr.,** formerly manager of sheet order



• Photograph courtesy Jones & Laughlin Steel Corporation Pittsburgh Works. Safety cover removed to show Fast's Spindle Coupling.

Fast's Spindle Couplings Mean More Profitable Rolling Mill Operations

★ *Up to 50% Less Down-Time*
★ *Quicker Disassembly*
★ *Bigger Savings on Maintenance*

The quick-disconnect and reliability features of Fast's Spindle Couplings may reduce down-time as much as 50%. Figured in dollars, this permits savings in production time in most rolling and blooming mill applications which can amount to thousands of dollars a month.

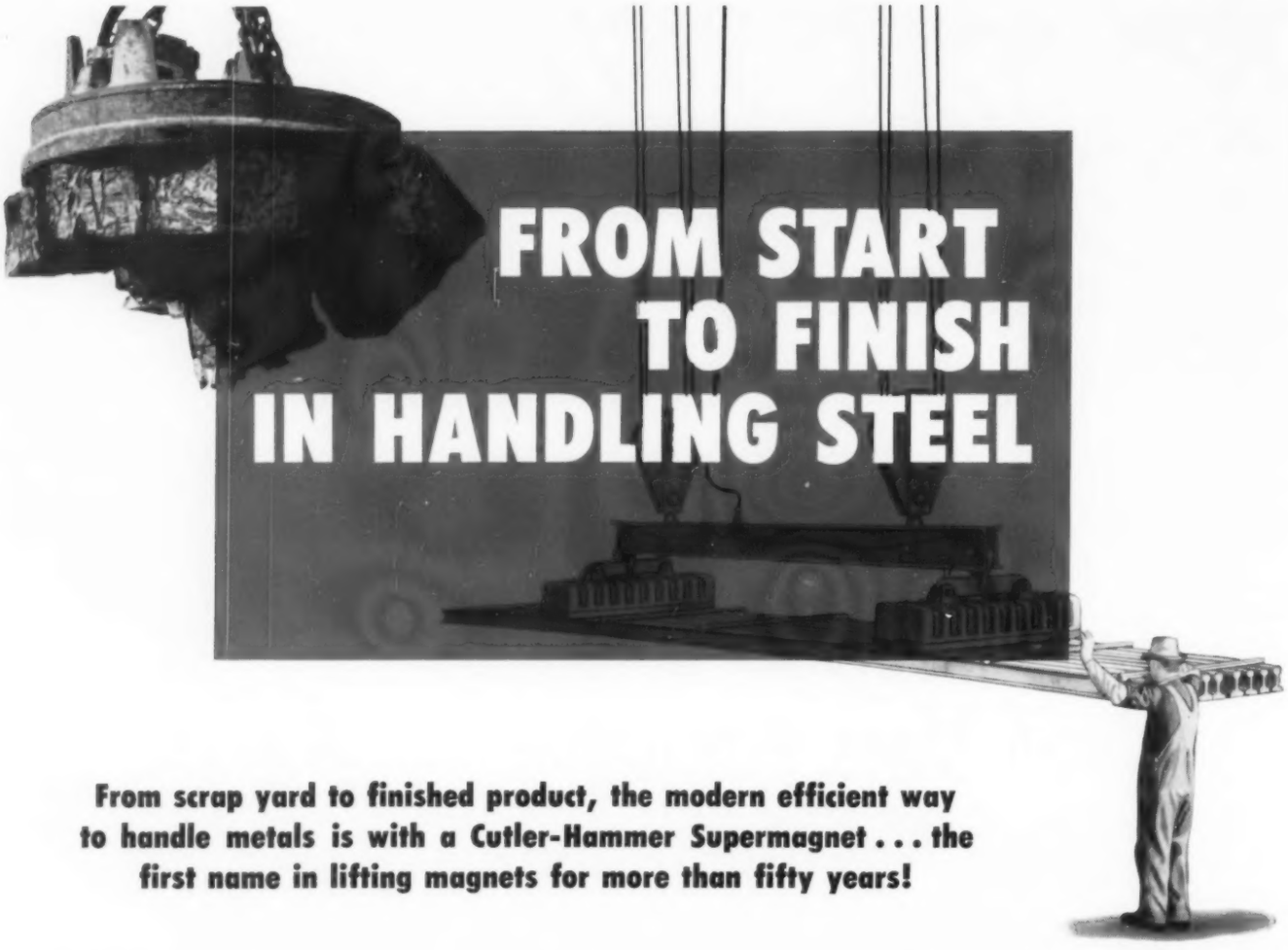
The new tooth configuration of Fast's Spindle Couplings compensates for a relatively high amount of misalignment with a minimum of backlash. It also permits constant angular velocity of the rolls which results in a marked improvement in the quality of the end product. Fast's Spindle Couplings are made of all steel construction with a metallic segmented conformable seal . . . completely self-contained and self-lubricated. They withstand the most rugged operating conditions, giving years of trouble-free service with only a minimum of maintenance.

Koppers' 38 years of experience in the coupling industry guarantees the right coupling engineered for a given application. To solve your rolling mill coupling problem write to KOPPERS COMPANY, INC., Fast's Coupling Department, 3003 Scott Street, Baltimore 3, Maryland.

Engineered Products
Sold with *Service*

KOPPERS

THE ORIGINAL
FAST'S Couplings

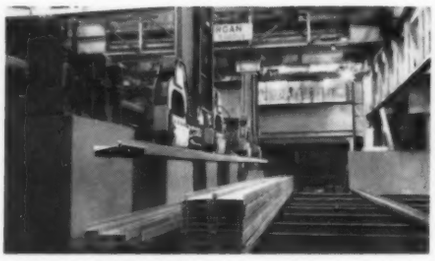


FROM START TO FINISH IN HANDLING STEEL

From scrap yard to finished product, the modern efficient way to handle metals is with a Cutler-Hammer Supermagnet . . . the first name in lifting magnets for more than fifty years!

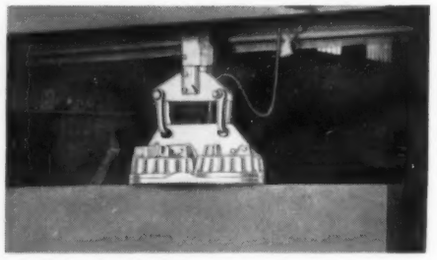
SPECIAL PURPOSE MAGNETS

Designed for specific applications, Cutler-Hammer Magnets can substantially reduce handling costs. As shown in the main illustration, Cutler-Hammer Rail Handling Magnets move multiple rails swiftly, efficiently, and safely.



BI-POLAR MAGNETS

These Cutler-Hammer Magnets are designed specifically for handling structural shapes such as I beams, angles, and channels. Cutler-Hammer Bi-Polar Magnets have played a major role in cutting the cost of classifying and stacking beams for shipment.

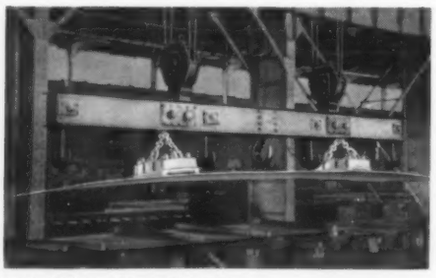


DUPLEX MAGNETS

This custom-built duplex magnet for slab turning in a scarfing department is a good demonstration of Cutler-Hammer's ability to design and build magnets for even the most varied and specialized applications.

CIRCULAR MAGNETS

Cutler-Hammer Supermagnets are known the world-over for their versatility, durability, and dependability. Perfect for handling iron or steel in any form, hot or cold, and in all kinds of weather. Available in either welded or bolted construction, sizes ranging from 39" to 77".



RECTANGULAR MAGNETS

Cutler-Hammer Rectangular Magnets provide maximum lifting capacities with minimum magnet weight . . . also save in crane equipment and daily power consumption. Perfect for regular shapes such as sheet and bar stock, etc. Heavy duty rectangular magnets recommended for handling billets, ingots and slabs.

CUTLER-HAMMER
SUPERMAGNETS
C-H

To solve your metal handling problem, look to Cutler-Hammer where you are assured not only the finest magnet on the market today, but the magnet that's perfect for your needs. Write today. CUTLER-HAMMER Inc., 1269 St. Paul Ave., Milwaukee 1, Wis.

allotment. Mr. Gibbs began his career with Kaiser Aluminum in 1949 as a salesman in Chicago. Since that time he has served as branch sales manager in Wichita, Kan., and assistant product manager of sheet products in Chicago. Mr. Griffith started with Kaiser Aluminum in 1950 as chief industrial engineer at the company's Trentwood, Wash., rolling mill and held several supervisory positions in the operation of the plant.

Vincent I. Rhodes has been appointed assistant superintendent of the Shops dept., Youngstown District, Youngstown Sheet and Tube Co. He joined Youngstown Sheet and Tube in 1937 as an inspector in the seamless tube mill. Subsequently he served as apprentice machinist, machinist, assistant foreman of the machine shop and planning engineer.

W. C. Higdon, manager of the Houston plant of Armco Steel Corp.'s Sheffield Div., was elected vice president in charge of planning and development, succeeding **F. H. Fanning,** who is retiring. **T. F. Olt,** director of research, was elected vice president—research. **W. F. Tuttle,** chief engineer of the Armco Div., was appointed director of engineering for the entire company. **J. B. Whitlock,** general maintenance engineer, has been appointed chief engineer of Armco Div. succeeding Mr. Tuttle. **K. P. Campbell,** general superintendent—operations, at the Houston plant, has been appointed manager to succeed Mr. Higdon, and **C. Leonard Lloyd, Jr.,** general superintendent—services, at Houston, becomes assistant manager.

Gilbert G. Schneider was appointed to head the sales dept. for Western Precipitation Corp.'s new product line—the Doyle-Turbulaire Scrubbers. He joined Western Precipitation's staff in 1951 as a test engineer and was subsequently transferred to sales activities in the Precipitator Div., working out of the Los Angeles offices. He was transferred to the New York offices, and later was assigned to the Atlanta and Pittsburgh offices.

J. E. Hughes, vice president of Henry J. Kaiser Co., has been appointed assistant general manager of the Kaiser Engineers Div. Appointed assistant to the vice president and assistant general manager, Kaiser Engineers in 1954, Mr. Hughes had earlier served as chief estimator and held various other engineering and managerial positions with the division.

Alex Shashaty was named chief engineer of Enterprise Co. Mr. Shashaty has been a project engineer for The Lombard Corp. for the last two years. Previously he was identified with Enterprise, Wean Engineering Co., and Inland Steel Co. At the same time, **Charles D. Shickley** was appointed assistant chief engineer. He has been associated with The Lombard Corp., Morgan Engineering Co., and the Enterprise Co. previously in various design engineering positions.

Edmund F. Martin and **Talbot Shelton,** each of whom is an executive of subsidiary companies of Bethlehem Steel Corp. were elected to fill vacancies on the corporation's board of directors. **Norborne Berkeley** was also elected as a vice president of the corporation. Mr. Berkeley is a director of the corporation and also an executive of subsidiary companies.

Floyd J. Titler, assistant chief industrial engineer in Republic Steel Corp.'s Cleveland general offices, and a veteran of more than 21 years' service with Republic, retired January 31. Mr. Titler, who is 65, has been with the company since 1936, when he was appointed district industrial engineer at Youngstown. He was promoted and transferred to Cleveland as staff industrial engineer in 1943 and was named assistant chief industrial engineer in 1944. Prior to joining Republic, he was associated with Westinghouse Electric Co.

Herbert G. Dent was named engineering consultant to the vice president in charge of operations, Joseph T. Ryerson & Son, Inc. Succeeding him as director of plant engineering is **Stanley J. Miller,** formerly assistant director. Both men will headquarter in the firm's general offices in Chicago.

C. Floyd Olmstead, president of Lee Wilson Engineering Co., was elected president of the Industrial Heating Equipment Association. **R. L. Harper,** executive vice president of the Harper Electric Furnace Corp., was named vice president. **Relph E. Whittaker,** secretary and treasurer of the Swindell-Dressler Corp. was re-elected treasurer; **A. E. Tarr,** assistant to the president, Leeds & Northrup Co., was elevated to the executive committee, and **Robert E. Fleming** was re-elected executive vice president.

John H. Corson, former manager of The Carpenter Steel Co.'s research laboratory, has been appointed manager of the company's Webb Wire Div., New Brunswick, N. J. Mr. Corson joined Carpenter as a metallurgist in 1952, became plant metallurgist—cold drawing a year later and, in 1954, was promoted to manager of the research laboratory. He started his metallur-

W. C. HIGDON

T. F. OLT

W. F. TUTTLE

J. B. WHITLOCK

A. D. McDADE

BRUCE MAYO

J. E. HOVIS

T. H. BRUMAGIN

gical career in the Development Engineering dept. of John A. Roebling's Sons Co., Trenton, N. J., in 1945. After serving as a metallurgist, he became head of the firm's metallurgical laboratory in 1947. Later that year, he became assistant to the president at Maryland Fine and Specialty Wire Co., Cockeysville, Md. He then became associated with the Bethlehem Steel Co., at Williamsport, Pa., where he served as metallurgist until 1952. Mr. Corson suceeds **Everett F. Waltman,** who was manager of the Webb Wire Div. since its acquisition by Carpenter in 1951.

A. D. McDade has been appointed chief engineer of the A. A. Straub Co., Inc. Mr. McDade was formerly associated with the Blaw-Knox Co., where for ten years he was process project engineer. Prior to this, he was associated with Gas Atmosphere, Inc. and American Cyanamid Co.

Bruce Mayo was named district manager of Link-Belt Co.'s Birmingham, Ala., district office. Mr. Mayo replaces **J. Ross Arnold** who has been appointed to handle a special assignment at the Link-Belt plant at Colmar, Pa. Mr. Mayo joined Link-Belt at the Caldwell plant in Chicago in 1945. In 1949 he was appointed sales engineer of special bulk handling and overhead trolley equipment, and in 1955 he was transferred to the Louisville district office as a sales engineer.

James E. Hovis has been appointed vice president in charge of sales for F.E.I., Inc. (formerly Furnace Engineers, Inc.). He was formerly vice president in charge of sales for Bloom Engineering Co., and more recently, manager of the Industrial Furnace Div. of Gas Machinery Co.

Thomas H. Brumagin has been appointed general sales manager of the Ajax Flexible Coupling Co. Inc. Mr. Brumagin has been associated with Ajax for 11 years in executive capacities in engineering, production and sales of Ajax products.

Walter D. Kramer has been named general manager of The Timken Roller Bearing Co.'s Columbus plant. Mr. Kramer replaces **Leroy D. Gable** who retired February 1. Simultaneously at the Columbus Plant, **Howard Starn** was named factory manager, **Fred Albright** was promoted to superintendent of the railroad bearing plant and **Marion J. Kowalski** was made assistant chief engineer.

Robert B. Kurtz has been appointed manager of manufacturing for the General Electric Co.'s General Purpose Control dept., Bloomington, Ill. Mr. Kurtz was formerly manager—manufacturing engineering for the department. He succeeds **F. C. Fisher** who was named earlier as general manager of the company's Ballast Dept. at Danville, Ill.

Obituaries

Thomas P. Butler, 68, chairman of the board and a director of Heyl & Patterson, Inc., died January 29. He had been associated with Heyl & Patterson for 39 years.

Charles M. Fitzpatrick, assistant superintendent of the blooming mill at the Sparrows Point plant of the Bethlehem Steel Co., died January 15.

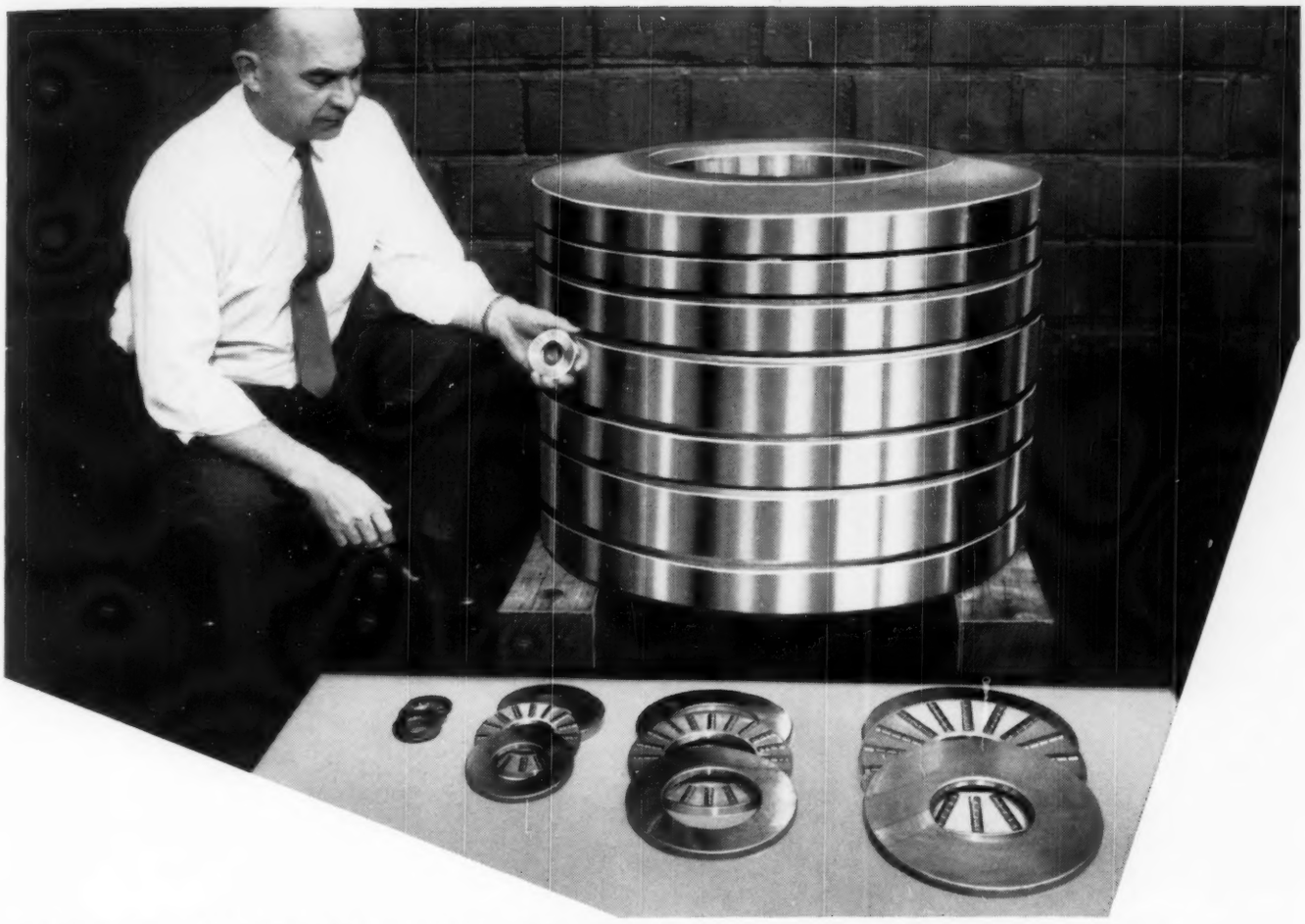
David J. Giles, senior vice president of the Latrobe Steel Co., died January 5. Mr. Giles was chief chemist at the Firth Sterling Steel Co. from 1915 until the end of 1918. He joined Latrobe Steel in 1919 and served in several capacities, assuming the position of senior vice president in 1950. He also was a member of the company's board of directors.

Frank X. Gilg, 57, an executive assistant in the boiler division of The Babcock & Wilcox Co., died January 26. Mr. Gilg joined B&W in 1922 as a draftsman at the company's former Bayonne, N. J., plant. He was subsequently appointed design engineer in the research dept. before being transferred to the New York service dept. in 1930. He was made a staff engineer in 1945, and an application engineer in 1948. In 1953, he was appointed executive assistant in the boiler division.

Call or Write STAMCO for...

Corrugating and Complete Line of Culvert Equipment—Slitting and Coiling Equipment for Ferrous and Non-Ferrous Material in All Capacities—Warehouse and Steel Mill Cut to Length Lines for Shearing and Levelling Sheets from Coils—Shears for Shearing Sheets and Plates Both Underdriven and Overdriven Types in all Capacities up to 1¼" plate.

STAMCO, Inc., New Bremen, Ohio



ROLLWAY THRUST BEARINGS...

36″ 2″

Design + precision + quality that do the job in the one best way...

Size in Rollway Thrust Bearings—big or little—is a mere matter of operating "geometry" and of the machinery to produce it. But design, precision and quality are dimensionless quantities that vary widely according to loads, speeds, temperatures . . . yet in the end sum up to a single constant: *"To do the job required in the one best way."*

Of course, we're proud of this 2¼ ton bearing with its thrust load capacity of 4,630,000 lb., its diameter of almost 3′-0″ and its 3 roll assemblies with 6 precision thrust plates matched to equalize load and deflections for each stage. But we're equally proud of the little 2 incher in Design Engineer Grigson's hand. Despite the great difference in size, each has been carefully worked out *"to do the job required in the one best way."*

Whether you want a bearing for an oil rig, an extruder, a pulp mill jordan, a crane hook, a heavy duty lathe and countless other uses, Rollway has one that will do the job "in the one best way."

ROLLWAY®
BEARINGS
COMPLETE LINE OF RADIAL AND THRUST CYLINDRICAL ROLLER BEARINGS

5 Standard Types:

- Single aligning
- Double aligning
- Tandem
- Single acting
- Double acting
- Special-purpose types to your order

See us at Booth No. 673
Design Engineering Show—Chicago

ENGINEERING OFFICES: Syracuse • Boston • Chicago • Detroit • Toronto • Pittsburgh • Cleveland • Milwaukee • Seattle • Houston • Philadelphia • Los Angeles • San Francisco

Announcing!

1958

IRON & STEEL EXPOSITION

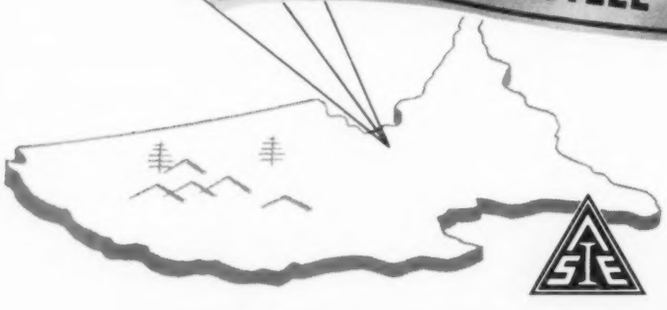
AUDITORIUM • CLEVELAND

SEPTEMBER 23·24·25·26

See the only show produced exclusively for the IRON and STEEL INDUSTRY!

Learn from the most complete range of exhibits ever shown!

Grow with your industry at the Biggest IRON and STEEL Show Yet!



ASSOCIATION OF IRON AND STEEL ENGINEERS

1010 EMPIRE BUILDING • PITTSBURGH 22, PENNSYLVANIA

NOW!

A BRAND-NEW CONCEPT IN FLOW TOTALIZING!

Continuous . . .
Pneumatic . . . FLYBALL INTEGRATOR

Inherently Accurate!

- Eliminates Inaccurate "Spot Check" Counting!
  Continuous integration assures highest precision.
- Eliminates Cam and Linkage Errors!
  Unique design balances differential pressure signal directly against centrifugal force.
- Eliminates Calculations!
  Automatically extracts square root — shows totals in desired units.
- Eliminates Fire and Explosion Hazards!
  Simple, all-pneumatic operation requires no electric motors, wires, or contacts.

FOXBORO
REG U.S PAT. OFF

Now you can integrate all your plant flow measurements, including oxygen . . . *continuously* . . . with new accuracy . . . complete safety! The all-pneumatic Foxboro Flyball Integrator completely eliminates intermittent counting and fire hazard. Its simple, force-balance operation utilizes the 3-15 psi air signal from any conventional differential-pressure flow transmitter. This signal is *continuously* balanced against the "flyball" force of the instrument's pneumatically-driven turbine. The square root function is automatically extracted . . . you read flow totals *directly*.

The Flyball Integrator mounts at the point of measurement or on a panel hundreds of feet away. Response and accuracy are completely unaffected by ambient temperature changes or pressure changes in turbine air supply. Ideal solution to all plant fluids accounting and in-process inventory checking. Write for complete details. **The Foxboro Company, 583 Neponset Ave., Foxboro, Mass.**

FIRST IN FLOW

Announcing a New Series of Technical Advertisements

by

FELLER ENGINEERING CO.

for

SCHLOEMANN AG

As a special service to readers of Iron and Steel Engineer, Feller Engineering Company inaugurates a new series of technical advertisements in this issue. The text and illustrations on the facing page are designed to present a general technical description of recent engineering developments by SCHLOEMANN AG. Succeeding advertisements will feature other new noteworthy achievements in the ferrous and non-ferrous metals processing industry.

Reprints available

We will be pleased to send you reprints of each advertisement without obligation. Please complete and forward the coupon below.

FELLER ENGINEERING CO.
1161 Empire Bldg.
Pittsburgh 22, Pa.

Gentlemen:
Please send reprints of your series of technical advertisements.

NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

CITY_____

FELLER ENGINEERING CO.
1161 EMPIRE BUILDING
PITTSBURGH 22, PA.

FELLER ENGINEERING CO.

presents

SCHLOEMANN

Rotary trimming and slitting shears for plates and sheets

One rotary shear line can handle the whole production of a modern plate mill. For example, in an eight-hour shift, a SCHLOEMANN rotary trimming shear cuts approximately 1,100 tons of plate up to $^3/_4$ of an inch thick; a similar shear trims plate up to $1^1/_8$ inches thick.

Highly mechanized

Heavy-type SCHLOEMANN rotary shears are fitted with electromagnetic manipulators and aligning equipment. The rotary knives are positioned both horizontally and vertically from the stand by means of remote control in increments of 4 thousandths of an inch. In particular cases, the vertical setting of the knives can be equalized by simple gears (DB patent). The cutting speed can be regulated over a wide range. If a third pair of knives is fitted which are laterally adjustable, the plates can be slit in the same operation. The complete rotary shear line is centrally controlled.

Automatic scrap choppers

Each SCHLOEMANN rotary shear unit has automatic scrap choppers which are known for their efficient operation. Depending on the type and thickness of the plates, choppers with either rotating cross-type knives, drum type knives or oscillating knives are used. Good operation of the choppers depends largely on the correct approach of the trimmings; a special guide has been developed for this purpose (German and foreign patents).

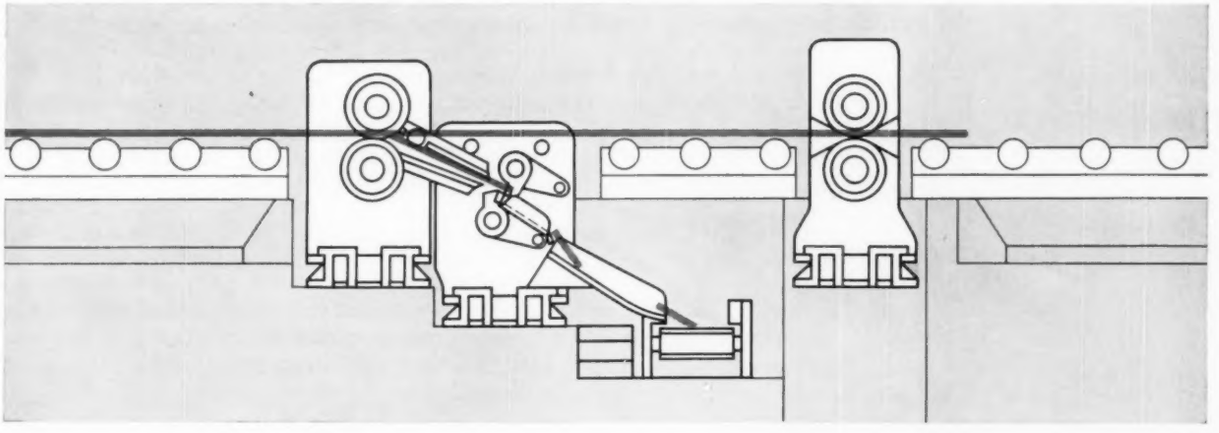
Rotary shear line in the Salzgitter plate mill

Summary

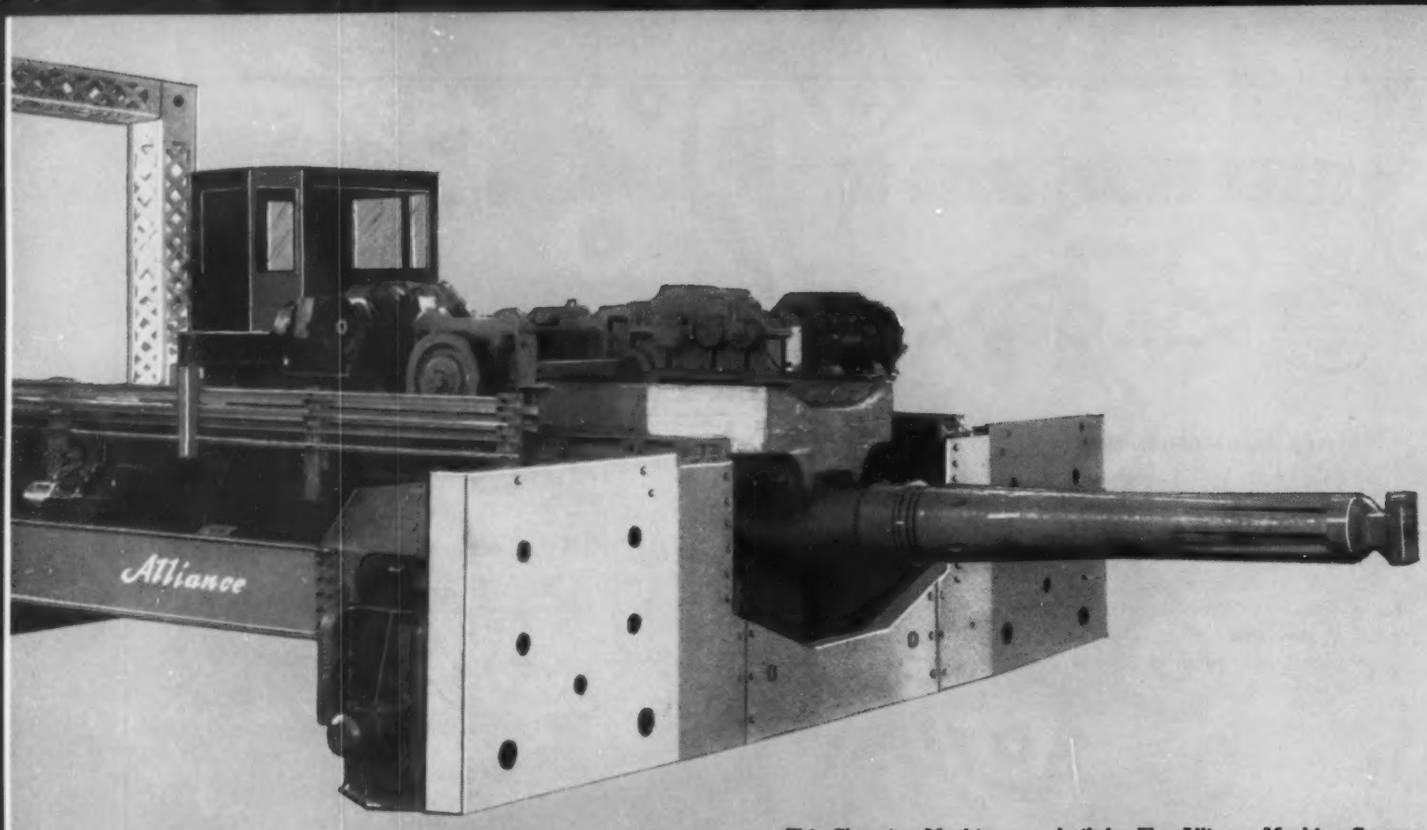
SCHLOEMANN rotary shears give a remarkably clean cut, and operations are greatly facilitated by the method of knife setting used and the dependable chopping of trimmings. At present SCHLOEMANN is building four rotary shear lines for heavy-gauge plates.

Rotary shear line: Trimming shear, scrap chopper, slitter

14 402



FELLER ENGINEERING CO., 1161 EMPIRE BUILDING, PITTSBURGH 22, PA.



This Charging Machine was built by The Alliance Machine Company, Alliance, Ohio . . . leaders in the heavy material handling equipment field for over 50 years. Contact Alliance for your requirements.

LADLE CRANES

GANTRY CRANES

FORGING MANIPULATORS

SOAKING PIT CRANES

STRIPPER CRANES

SLAB AND BILLET CHARGING MACHINES

OPEN HEARTH CHARGING MACHINES

SPECIAL MILL MACHINERY

STRUCTURAL FABRICATION

COKE PUSHERS

New 12-TON CHARGING MACHINE

• **The NEW Alliance 12-ton,** low-type open hearth Charging Machine has spring-loaded pitman so, if the charging box pushes up over scrap in the furnace, the trolley's front wheels remain on the rails. Trolley always has sufficient traction to retract peel and box from furnace.

• **Each bridge girder** of Alliance's NEW Charging Machines consists of two wide-flanged I-beams welded to form a box section. Between webs of this box section, diaphragms are welded at 3-ft. intervals. This, plus other welded reinforcements, keeps charging machine square and rigid.

• **Machinery deck plate,** extending full length of bridge between main girder and outrigger girder, laterally reinforces the main girder and helps keep charging machine square and stable under all operating conditions.

• **Stabilized, shock-absorbing wheels** operate at rear end of trolley. Two rear wheels engage upper rail; two adjacent wheels engage lower rail. Powerful springs hold wheels in contact with rails at all times. This spring suspension absorbs and disperses engaging and disengaging shock at end of the peel, reducing operator shock and fatigue to a minimum.

• **On eight-wheel bridges,** the four trucks located at corners of the bridge are equalized to compensate for any track irregularities.

• **New hydraulic lock rod** gives operator finger-tip control and eliminates laborious work incident to the hand-operated lock rod. All gears (including track wheel gears) are fully enclosed and run in oil.

WORLD'S LARGEST BUILDERS OF WORLD'S LARGEST CRANES

Founded 1901

THE *Alliance* MACHINE COMPANY

MAIN OFFICE • ALLIANCE, OHIO

GIVE US THE RUNWAY AND WE'LL LIFT THE WORLD

Equipment News...

PRECIPITATOR ELECTRODE

△ Successful application of a new type of electrode for industrial gas cleaning and air pollution control has been revealed by the Metal Products Div. of Koppers Co., Inc. The new device, according to Koppers, achieves complete control of the corona discharge on the energizing electrodes of electrostatic precipitators and thus greatly increases their efficiency.

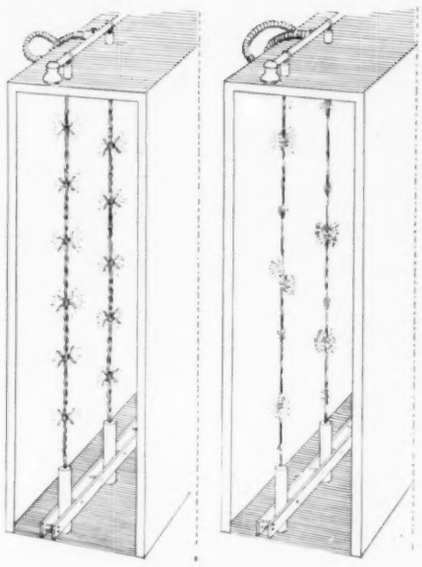
Disclosure of the new device was coupled with announcement that it has been performing successfully for approximately a year in a major steel plant in this country, at a large power generating plant in England and in cement plants in Germany and Hong Kong.

With this performance record, plus the protection afforded by patent applications, Koppers has moved into production of the new electrode and already has accepted contracts for installations in ten large industrial plants.

The electrostatic precipitator removes solids from flue gases by subjecting them to an electrical charge. As the gases pass through the precipitator "fields," the solid particles receive a negative charge from wire energizing electrodes and are then attracted to grounded collecting plates. The efficiency of the unit is in direct proportion to the power that can be introduced into the energizing electrodes without a "flash-over" to the collecting plates.

Collected material tends to build up on the surface of these plates and must be dislodged by frequent, automatic rapping to minimize its insulating effect.

To a lesser degree this build-up also occurs on the energizing wire electrodes, and here its insulating effect tends to produce an unpredictable and uncontrolled pattern in the corona discharge which is the key factor in the precipitating action. Where dust clings to the wire there will be less corona discharge. This insulating action, by forcing greater concentrations of corona on clean sections of the wire, tends to produce at those points a quicker "flash-over" in relation to the applied power.



As waste gases pass through the precipitator, suspended solids receive a negative charge from the wire electrodes and are attracted to—or "precipitated" on—the adjacent walls, then are jarred loose and fall into collecting hoppers. Some of the dust, however, clings to the energizing wires insulating them at those points and producing too-heavy concentrations of current in the clean areas, shown by the irregular corona clusters in the right half of the drawing. The Koppers solution is to use a wire with evenly spaced groups of barbs, as in the left panel. These sharp points remain clean and the corona discharge, consequently, remains under a constant control.

Even though the energizing electrodes also are rapped at frequent intervals no way had been found to prevent uneven accumulation of dust and hence an uncontrolled corona discharge.

The new Koppers application solves this problem by substituting for the conventional straight-wire energizer an electrode which closely resembles ordinary barbed wire.

Suspended vertically between the collecting plates, the new wire has demonstrated that, whatever insulating material may build up on the main wire, the barb points remain clean and the corona discharge, therefore, occurs constantly at those points.

By proper spacing of these barbs complete control of the corona discharge can be achieved throughout the entire precipitator.

Possessing this control, Koppers precipitator engineers have found in their year of testing, that they can impress on the energizing electrodes considerably greater power than on the conventional wires and thus gain appreciably higher dust-collecting efficiency without any other enlargement of the equipment.

By using the controlled corona discharge electrodes, substantially greater power may be applied, and higher efficiencies obtained, in existing equipment, thus permitting operation appreciably beyond original designed capacity. Also, in new designs, smaller precipitators can now be offered for dust loadings and gas volumes that would require larger units when equipped with conventional discharge electrodes.

VIBRATING SCREENS

△ Hewitt-Robins, Inc., has announced the manufacture of a new line of vibrating machines of special design to screen and move hot sinter as it comes off the sintering line in steel mills.

The decks of the new machines, and other members exposed to the abrasive wear of sinter, are made of special steels, such as cast chrome molybdenum, which resist changes in physical characteristics at temperatures ranging from 1000 to 1400 F. High-temperature alloys are also employed for critical fasteners, structural, and support components. Means are provided for thermal insulation and cooling of the vibrator, the lubricant, and critical structural members. Unique design considerations also provide for the expansion of deck and related sections under the extreme temperatures to which they are directly subjected.

The machines are installed immediately after the crusher where sinter slab is broken into lumps and discharged into the coolers. Sections of the decks are equipped with grid

These Goggle Plates
Operate Easily Even in Large Sizes

Bailey
MECHANICAL
Goggle Valves

Regardless of how long they may stand unused, Bailey Goggle Plates free easily to close or open the gas main. With goggle plates either closed or open, a powerful clamping force assures a gas-tight seal—dependable protection for men and equipment.

WILLIAM M. Bailey COMPANY
ENGINEERS
LEADERSHIP THROUGH QUALITY
1221 BANKSVILLE ROAD PITTSBURGH 16, PA

bars with openings in the ¼-in. to ⅜-in. range. Sinter lumps suitable in size for blast furnace feed move over the top of the grid bars to the coolers, and fines that are too small for the blast furnaces fall through the grid openings and are fed back to the head end of the sintering machine to be recycled and combined with the make-up sinter mix.

Hewitt-Robins is manufacturing two basic types of machines for this application. One is an Eliptex full-floating screen mounted on coil springs, and the other is an Eliptex vibrating conveyor-screen mounted on rocker arms. The new designs incorporate the latest improvements made possible by operating experience with earlier models.

HYDRAULIC OPERATOR

△ Extension of hydraulic closing mechanism to Allis-Chalmers Manufacturing Co.'s 600 and 225-ampere electrically operated, low-voltage air circuit breakers has been announced by the company.

The hydraulic operator, which permits closing directly from an a-c power source with low control power requirements, has been available on Allis-Chalmers 1600-ampere low-voltage breakers since 1955.

The smooth and quiet fast-closing action of the breaker reduces stress on operator and contact components. Since the unit is completely sealed and requires no adjustments, maintenance is kept to a minimum.

Rear access ports to the breaker's trip devices permit easy replacement of the continuous current coils without disturbing the trip unit itself. The dual magnetic, selective and thermal trip devices for the 225-, 600- and 1600-ampere breakers are all interchangeable.

The control and auxiliary relays are protected by a removable steel cover to provide a "dead-front" unit and easy accessibility to components.

PLATE HANDLER

△ Designed for attachment to cab or floor-operated overhead cranes, a one-man "pushbutton" plate and sheet handler is now in production by Noble Co.

After installation of a permanent saddle on the crane trolley, the plate handler can be attached or re-

A new dimension in flexibility!

You get *up to 70°* usable working angle (or equivalent shaft offset) with *two* Rzeppa Constant Velocity Universal Joints connected for double-action flexibility.

Rzeppa (pronounced "Sheppa") Joints, used singly or in combination, give 100% smooth torque with the strength and capacity required by heavy-duty coupling and drive-line applications. And every Constant Velocity Universal Joint is built for a long life of trouble-free service.

Call or write today for performance and engineering facts on the complete line of Rzeppa Constant Velocity Joints for every aircraft, marine, vehicular and industrial speed.

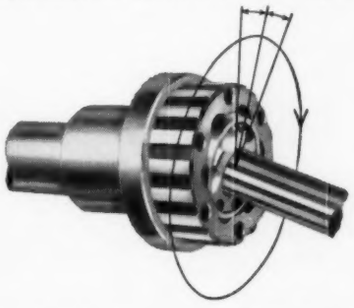
RZEPPA "SHEPPA" *Constant Velocity Universal Joints*

58RJ-1

THE GEAR GRINDING MACHINE CO., 3929 CHRISTOPHER, DETROIT 11, MICHIGAN • MANUFACTURERS OF: FULLY AUTOMATIC GEAR GRINDING MACHINES, DETROIT SCREWMATIC 750 SINGLE SPINDLE SCREW MACHINES

Plus RZEPPA'S smooth money-saving action

Old-fashioned pin or slipper-type joints speed up and slow down twice during one revolution, must use precision alignment techniques to compensate for "rock and roll" action at extreme angles.



Rzeppa Joints operate without chatter or bounce. Ball bearings deliver smooth rotation, reduce friction for longer joint and shaft life.

ANOTHER COMPLETE® RAMTITE NEW FURNACE ENCLOSURE

This time a new Surface® triple fired reheat furnace at a midwestern steel mill . . .

. . . and past performance paved the way.

In case after case, Ramtite's cost reducing performance has paved the way to new furnace orders.

When this new reheat furnace (67′ x 19′), built by Surface Combustion Corporation, was installed last September, Ramtite was used for a complete enclosure: side walls, burner walls, roofs and downtake.

In the old furnace which this one replaced, a Ramtite sidewall paid for itself over and over again.

Performance such as this is the reason for Ramtite's ever growing use in both new and existing furnaces throughout the nation.

The Ramtite Co. offers you a complete sales engineering service. Experienced men are always available to study your refractory problems and consult with your Engineering, Mason and Ceramic Departments about your specific needs.

Write us today for further information.

The Ramtite Co.
DIV. OF THE S. OBERMAYER CO.

1813 SOUTH ROCKWELL STREET — CHICAGO 8, ILLINOIS

PRECIPITATOR VALVE

Two of these 8-ft, 6-in. ID butterfly valves are being installed in the basic oxygen furnace process in the Aliquippa, Pa., works of the Jones & Laughlin Steel Corp. They were fabricated by Blaw-Knox Co.'s Equipment Div. under contract to Kaiser engineers, designers and constructors of the J & L expansion project. Forming a part of the electrostatic precipitator circuit of the dust collection and gas cleaning system, the valves will handle 235,000 cfm of gas at 500 F. Water cooling will be used to protect the units rather than the conventional refractory lining, and the disks will be operated through pneumatic controllers.

moved from the crane in three minutes or less, permitting normal crane operation for other work. In use, the operator lowers the handler until its vacuum cups contact the plate, then pushes the hoist button. As the plate is raised, air-powered mechanical safety grabs automatically slide into place. "Stiff-leg" support columns steady the load to prevent swaying or swinging, and to permit accurate positioning of the plate on feed tables, ball points or pile. The plate can be picked up from or set down flat on the pile or floor without blocking, and is released at the touch of a button after load is "landed."

Standard lift capacities range from 1000 to 4000 lb. Other capacities are available.

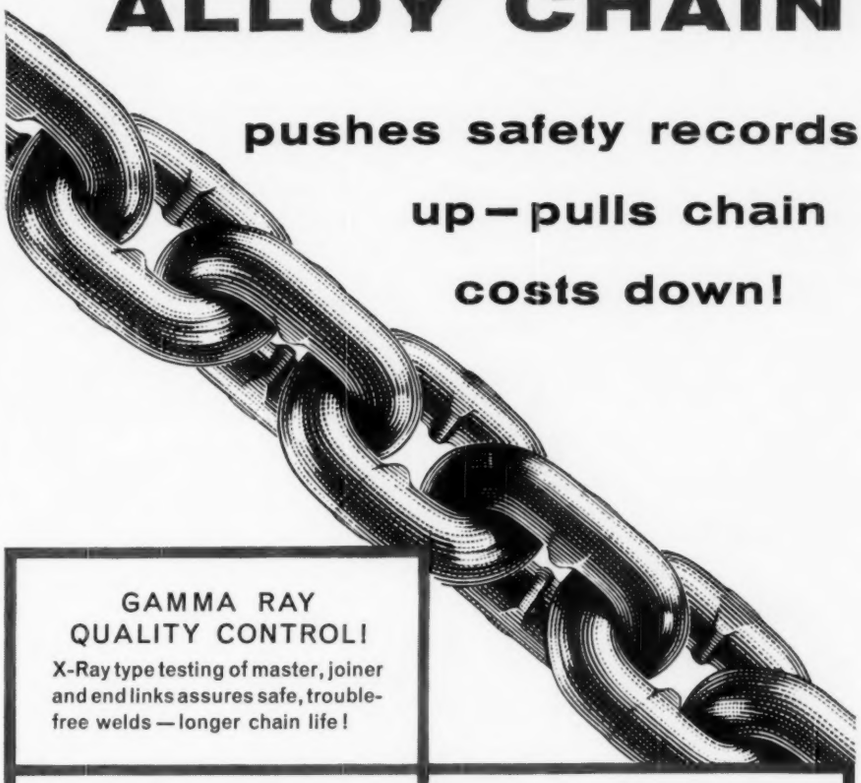
SCREW CONVEYOR

△ A screw conveyor drive that is simple to mount and adjust on standard conveyor troughs is the newest addition to the Dodge Manufacturing Corp.'s line of power

TM Triple-Safe

ALLOY CHAIN

pushes safety records up—pulls chain costs down!



GAMMA RAY QUALITY CONTROL!
X-Ray type testing of master, joiner and end links assures safe, trouble-free welds—longer chain life!

CONTROLLED ATMOSPHERE HEAT-TREATING
on all popular alloy chain sizes provides uniformity throughout the sling assembly.

EXCLUSIVE PATENTED TAYCO HOOKS!
I-Beam type design . . . alloy steel construction and unique recessed grip mean extra safety!

REGISTERED! You get a certificate of test with every TM Alloy Chain. It bears the chain's guarantee . . . proof test . . . serial number.

You alleviate the squeeze on profits and tighten your grip on safety when you switch to TM Alloy Steel Chain. Gamma Ray Quality Control . . . Controlled Atmosphere Heat-Treating . . . new patented Tayco Hooks make it *Triple-Safe*—last many times longer than low-carbon steel chain. Never requires annealing! Tough—withstands abrasion, shock, grain-growth and work-hardness. Get *all* the facts! Write for Bulletin 13 right away!

Chain is our specialty, not our sideline!

TAYLOR MADE A GREAT NAME IN Chain SINCE 1873

Contact your nearest Distributor or write
S. G. TAYLOR CHAIN CO., INC.
Plants: Box 509, Hammond, Indiana
3505 Smallman St., Pittsburgh 1, Pa.

transmission equipment.

The unit embodies a new concept in application and several new features in design which have had wide acceptance in industry. It consists of a speed reducer with packng gland and driving shaft, which mounts on the trough end. Trough ends also are offered by Dodge in sizes to fit most standard conveyors.

Maximum efficiency is achieved through the use of heat-treated helical steel gears and pinions.

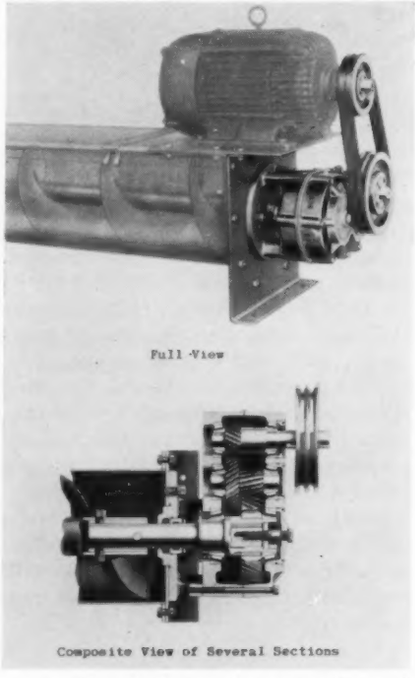
Design of the new drive insures the utmost protection for the speed reducer unit against invasion by the material being handled by the screw conveyor. The packing gland is adjustable from the outside, takes standard packing and may be inspected by sight. Any material that might work through the packing would fall to the floor instead of forcing its way into the reducer.

A flinger seal on the shaft next to the reducer also prevents liquids or other foreign matter from reaching the reducer seals. A third barrier against contamination is provided by double lip reducer seals.

Simplicity and economy are achieved through elimination of the usual sliding motor base. Instead, slotted holes in the flange of the reducer permit the unit to be rotated for quick and easy adjustment of the V-belt drive center distance. Both the motor and the drive may be mounted in any position.

Another economy feature lies in the fact that heavy-duty tapered roller bearings in the reducer eliminate the need for a separate thrust bearing. These bearings take thrust in either direction.

The reducer with packing gland and driving shaft may be mounted



or removed from the trough end easily and quickly by means of three bolts in the reducer flange. The driving shaft is mounted in a steel sleeve, and a built-in puller facilitates changing the driving shaft without opening the reducer itself.

Screw conveyor drives are available in four sizes which cover 95 per cent of the requirements of industry. Each size is offered in two ratios, 18 to 1 and 8 to 1. Output speeds may be chosen from preselected V-belt drive tables.

EXTRUSION PRESS

△ Sutton Engineering Co. has announced a 1500/1870 ton extrusion press, especially designed for dependable, high-speed production of brass and other copper-alloy rods and shapes. The new press will operate at 90 in. per min, with provision for increase to 120 in. per min.

Two 350-hp motors drive four Oilgear pumps, two of which are of the DY type. Either or both sets of

for intense concentration of heat...

The BLOOM HTR BURNER

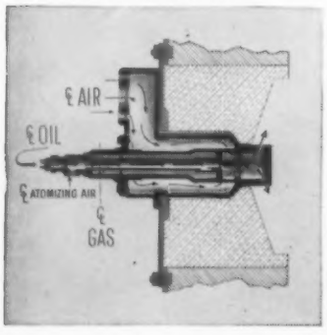
The Bloom HTR Burner provides identical operation on either gas or oil.

This burner enables the engineer to design a heat pattern with excellent results, because it has the unique characteristic of providing localized high heat release with low forward velocity. The burner can be located to fire directly at the material without flame impingement. Roof firing is easily accomplished and provides uniform hearth temperature.

This burner has been very successful in its application to tube upset furnaces; continuous strip annealing, coating, and pre-heating lines; high speed billet heating furnaces; and batch-type forge furnaces.

The Bloom High Thermal Release Burner with its sturdy construction is ideal for applications requiring speed and precision heating.

PATENT PENDING



BLOOM ENGINEERING CO., INC.
857 W. North Avenue Pittsburgh 12, Pa.

pumps may be used for operation. Control of the operating cycle reduces time required for operating judgment as the auxiliary motions of the press can be preset and repeated automatically.

Material handling is unique to the extent that the press is of the lateral die slide design and yet permits the technique of extruding with a shell. Handling of the shell is accomplished by use of a gripper in the die slide and full length container stripping cylinders. A scrap handling elevator is provided to pick up the shell after discharge and raise it to the separate dummy knocker press. The dummy knocker press is arranged with an anvil for dislodging the dummy block and with a parallel second cylinder platen which crushes the shell to reduce storage space and scrap handling time.

Mechanical and hydraulic maintenance has been made easy by emphasis in design on accessibility of all basic components.

SWITCHES

△ Micro Switch, a division of Minneapolis-Honeywell Regulator Co., has announced a new, improved design for its line of Type "E" general-purpose enclosed switches.

The switches feature a compact enclosure that provides for easy installation, with a design that exposes the inside switch terminals for easy wire connection by separating the enclosure into two halves.

A second major improvement is a new one-piece molded neoprene insulator-seal that is cemented permanently into the bottom half of the enclosure. This replaces the wrap-around insulator and separate gasket formerly used to simplify handling and improve the insulating and sealing qualities of the switch.

Other improvements of the new switches (designated Type "E6" for side mounting and Type "V6" for bottom mounting) include a more rugged housing, a hex-shaped conduit hub and improved appearance.

The new enclosure is available in five different integral actuator designs and in side- or bottom-mounted types. All types are interchangeable with the company's older Type "E" and "V" designs.

Standard Type "E6" and "V6" switches have single-pole double-throw contact arrangement. Their UL electrical rating is listed at 15 amp 125, 250 or 460 vac; ½ amp vdc; ¼ amp 250 vdc. The basic switching unit is replaceable.

MOTORS

△ The Louis Allis Co. recently announced the availability of a line of weather protected motors, designed for outdoor operation under extreme weather conditions. The new line is manufactured in ratings from 250 to 1500 hp.

Use of the motor is anticipated in pipeline, boiler feed pump and other outdoor industrial applications. The manufacturer states that it provides reliable service in extremely high winds, in driving rain, snow, sleet and sandstorms.

The motor's ventilation system prevents the entrance of wind-borne particles and moisture by forcing the incoming airstream through a number of abrupt changes in direction and sharp decreases in velocity.

Standard features include split sleeve bearings and bearing brackets that allow on-the-job removal or inspection; newly developed moisture and chemical resistant insulation; low temperature space heaters to minimize condensation during shutdown periods; "drive-by" oil level sight gages; and inspection ports for observing oil rings while motor is operating.

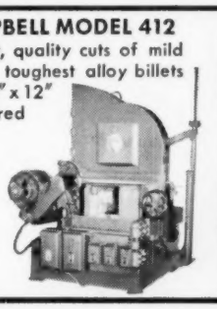
Optional features include a pres-

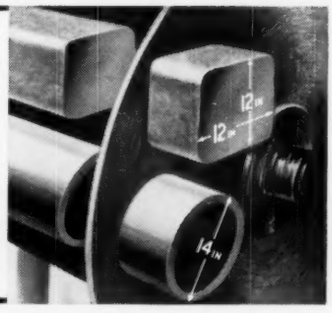
Campbell
Abrasive Cutting Machines

Abrasive Cutting Know-How

Know-How is just as vital to top performance in abrasive cutting as in any other machine tool operation

CAMPBELL MODEL 412
For fast, quality cuts of mild steel or toughest alloy billets up to 12″ x 12″ as pictured





Users of Campbell Abrasive Cutting Machines get Tremendous Savings with Fast, Accurate, Quality Cuts of Mild Steel or Toughest Alloys

Write us and we will gladly send you helpful information on the working capacities of the 16 models of CAMPBELL Machines and the CAMPBELL Operating Features that explain the outstanding performance of these machines in cutting a wide variety of shapes and sizes of stock—channels...bars and tubing from the smallest to 14″ diameter ...plate up to 4″ thick and 20 feet long ...billets up to 12″ x 12″.

CAMPBELL Machine performance is well illustrated by the **Model 412** pictured above. This machine cuts through 12″ x 12″ billets of mild steel or toughest alloys (even titanium) in the almost unbelievable time of 6 to 10 seconds per square inch...*with quality cuts.*

Here are some of the operating features that account for comparable speed and quality of cuts by CAMPBELL's 10 high speed production models...two of them fully automatic for highest production.

Oscillation of the Cutting Wheel to maintain cutting speeds and greatly lengthen wheel life is prescribed by CAMPBELL for all solids cuts over 2″ in diameter.

Wet Cutting gives maximum assurance of Quality Cuts.

Ample Power, essential to good performance, is supplied for the Model 412 by a 40 HP motor.

Sound Work Holders — essential to accuracy.

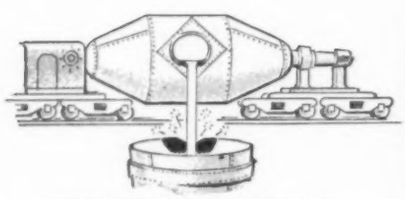
For greatest abrasive cutting accuracy, CAMPBELL provides two oscillating machines that rotate the work—round bars or tubing from 3″ to 14″ diameter.

For further information write for the illustrated Bulletin DH-460-B

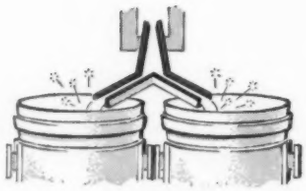
ACCO

Campbell Machine Division • AMERICAN CHAIN & CABLE

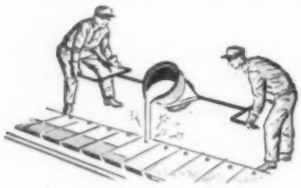
928 Connecticut Avenue, Bridgeport 2, Connecticut



Throat and Lips of Transfer Car



Open Hearth Bifurcated Spouts



Hand Ladle Into Mold

Laclede Slagtite

FOR CLEANER METAL, LOWER COSTS, LONGER LINING LIFE

specify LACLEDE *Slagtite* REFRACTORY

LACLEDE SLAGTITE, a slag-repellent refractory, keeps equipment cleaner, longer, which makes for cleaner metal. It minimizes inclusions and resists thermal shock. And it comes in two forms—Plastic and Dry—for use wherever molten metal or slag is carried or contained.

IN OPEN HEARTH departments, *Laclede Slagtite* is used for ladle patching, ladle slag spouts and spouts on open hearth furnaces, and rounding out bottoms of steel ladles which have a molten metal capacity of approximately 100 tons.

IN BLAST FURNACE departments, use *Slagtite* for main iron runner and tap hole application. 10% *Slagtite* Dry is charged in gun mix for plugging blast furnace iron tap holes.

CONTACT your local field representative for information on how *Laclede Slagtite* can be used to advantage in your plant. He's listed in the Yellow Pages, under "Refractories". Or write to *Laclede-Christy Works, Refractories Division, H. K. Porter Company, Inc., St. Louis 10, Mo. In Canada, H. K. Porter Company (Canada) Ltd., Guelph, Ontario.*

H. K. PORTER COMPANY, INC.
REFRACTORIES DIVISION

sure lubrication system, air filters for highly contaminated installations and temperature protective devices.

ROLLING MILL

△ The development of a heavy-duty, high-precision 2-high/4-high combination rolling mill for application in metallurgical production and research work has been announced by Loma Machine Manufacturing Co., Inc.

The machine is equipped with mill housings, roll journals, universal spindles and a drive transmission of extra large capacity. This heavy-duty design allows the mill to take reductions of more than 50 per cent per pass while maintaining tolerances as close as 5 per cent of thickness.

Change-over from the 6 in. x 8 in. 2-high to the $1\frac{1}{2}$ in. and 6 in. x 8 in., 4-high setup requires only 20 min. The 2-high arrangement is used for either hot or cold breakdown rolling of plate and sheet, and grooved rolls are also available to process rounds, squares and other shapes. In the 4-high setup strip is cold finish rolled to gages as thin as 0.001 in.

An optional feature allows this versatile mill to be arranged also for the direct compacting of powder into sheet and strip. For such a metal powder rolling operation a special feed hopper is applied to the 6-in. 2-high rolls which can produce compacted materials up to $\frac{1}{16}$ in. thick.

The mill is furnished with high-strength steel housings, twin-handwheel wormdrive screwdowns, universal joint spindles, herringbone gearing, and a 15 hp four-speed gearshift drive. The rolls are made of forged alloy steel and are hardened to 100 Shore Scleroscope. The roll necks are mounted in super-precision needle roller bearings having a total separating force capacity of 175,000 lb.

CONTACTOR

△ Introduction of a new size 8 (Type 425-8D) a-c clapper-type 3-pole magnetic contactor rated 1350 amp at 600 volts, has been announced by Allis-Chalmers Manufacturing Co.

Incorporating the same basic de-

CUSTOM ENGINEERED RECTIFICATION

GERMANIUM • SILICON • SELENIUM

We don't make pop-up toasters or television sets—our business is Semiconductor Power Conversion Equipment and Systems. This intense specialization for the last 15 years assures you of the best rectifier equipment it is possible to build—plus the flexibility of modifying designs to meet specific, exacting requirements. Such valuable EXTRAS are evident in every Sel-Rex Rectifier installation.

Our 32-page "Guide" to Metallic Power Rectifiers gives details on equipment for industrial power conversion applications. This fully illustrated booklet covers: Mag Amp Regulated DC Power Supplies; Current Limiting Rectifiers for DC Arc Furnace applications; Battery Chargers; complete Semiconductor Rectification Systems for the operation of electrolytic cells; and many others.

Whether your interest is practical or academic, "Guide" To Metallic Power Rectifiers will be a valuable source of information. Please request your FREE copy on your company letterhead.

Rectifier Division

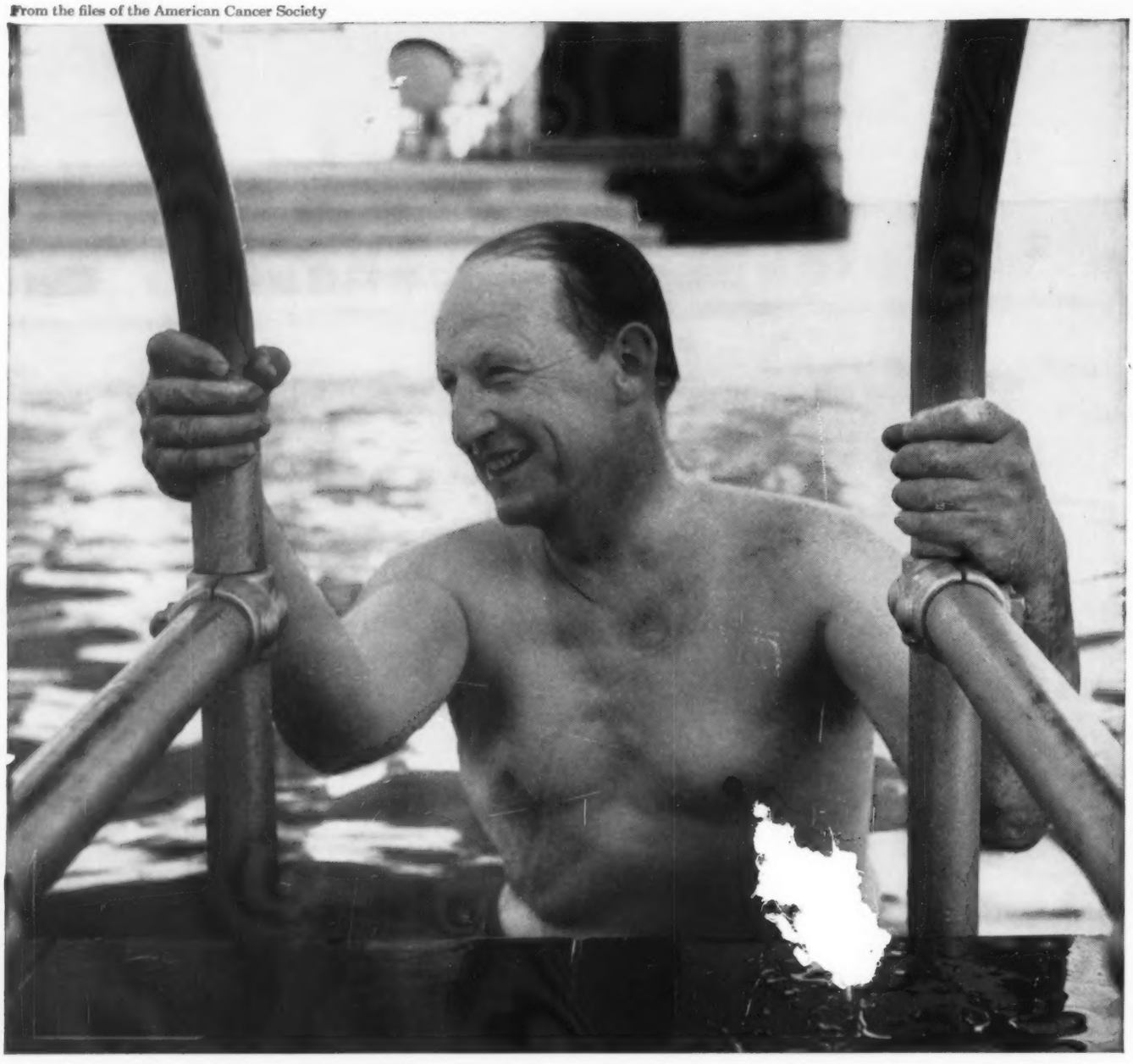
SEL-REX CORPORATION

Nutley 10, New Jersey

Representatives in Principal Cities

Complete Semiconductor Power Conversion Systems for any A. C. to D. C. application.

From the files of the American Cancer Society



Yes! I had cancer

"Many people believe that cancer is incurable. They're wrong and I can prove it! And there are 800,000 other Americans like me.

"On a gray morning in November, 1942, a specialist confirmed the diagnosis of cancer made by my family doctor. What he had to say reassured me.

"He explained that, thanks to my habit of having yearly checkups, my doctor had caught the cancer in its early stage. It was localized and operable . . . and here I am, hale and hearty."

That was 15 years ago, when only 1 out of 4 persons with cancer was being cured. Today, thanks to improved methods of treatment, and earlier diagnosis, 1 person in 3 is being saved.

And with present knowledge, it can be 1 in 2, if everyone observes two simple precautions: Have a health checkup annually. Keep alert for cancer's seven danger signals.

Progress in the American Cancer Society's fight against cancer depends on the dollars donated for its broad, nation-wide program of research, education and service to the stricken.

Help save more and more lives from cancer. Fight Cancer with a Checkup and a Check. Send a check *now* to "Cancer," care of your local post office.

AMERICAN CANCER SOCIETY

sign features as found in Allis-Chalmers size 4, 5, 6 and 7 contactors, the new unit augments the line of Type 425 devices to provide a range of heavy duty contactors from 150 to 1350 amp.

Compact, yet easily accessible, the contactor features ACBO arc interruption, self-alining bearings and mill-duty auxiliary interlocks. It is only 39 in. wide, 19½ in. high and 17⅝ in. deep. It is mounted on a 1½-in. ebony asbestos panel. Available in either two or three poles alternately mounted with the magnet assemblies, the contactor is d-c-operated from a 110-volt a-c rectified source.

The conventional blowout coil and its connections are eliminated by means of the ACBO arc interruption principle, resulting in a clean-cut, readily accessible device. Through-air clearance of 11½ in. between poles provides ample room for wiring or busing to load and line terminals.

D-c operators eliminate hum and chatter, pick up 65 per cent of rated voltage and hold in with as little as 35 per cent rated voitage. The magnet is unaffected by corrosion or foreign matter. A solid magnet and armature provide longer mechanical life. Movable and stationary contacts are identical; self-alining bearings require no maintenance. Operating shaft extension facilitates simplification of mechanical interlocking. Up to four NO and four NC auxiliary contacts can be mounted on a 3-pole contactor.

The contactor is particularly adapted for opening and closing the circuit to the heating element of electric ovens and furnaces. It is also used in conjunction with other control devices to start motors up to 900 hp maximum at 440 volts and 450 hp maximum at 220 volts to control motor-driven presses, stitchers, pumps and fans such as are used in steel mills, metal fabrications plants and by control assemblers.

This type of contactor is also being used by air conditioning manufacturers to control compressors.

POWDER LANCE

△ The Oxweld ACL-3 powder lance, a revolutionary new tool capable of cutting through concrete or metal of any thickness, has been introduced by Linde Co., division of Union Carbide Corp. Materials that were previously difficult or impossible to pierce with other methods can now be pierced and cut with comparative ease and speed by powder-lancing.

Accurate control of intense heat is the key to operating the ACL-3 lance. Lengths of standard black iron pipe are fitted into the front end of the unit, which is connected to an oxygen supply and a source of special Oxweld metallic powder. The oxygen and metallic powder are mixed in the pipe and carried to the material being pierced or cut by the consumable pipe. This mixture is ignited at the end of the iron pipe, producing an extremely high temperature reaction that melts both ferrous or non-ferrous material in its path. On materials such as concrete, aluminum powder is added to the metallic powder to intensify the cutting reaction.

Extensive field tests indicate that there is *no limit* to the thickness of material that can be pierced by powder-lancing. On construction and demolition jobs, for example, the lance can be used to make vertical and horizontal cuts in concrete without noise or vibration. It is especially valuable on jobs where blasting cannot be employed, mechanized methods are too costly, or time is an important factor. In steel mills and foundries, time-consuming jobs as opening slag pockets, cleaning soaking pits, de-skulling ladles, furnace tapping and salamander removal can now be handled faster and far more efficiently with the ACL-3.

Operation of the lance is simple. Oxygen and powder valves operate independently allowing the operator to shut the powder off at any time during lancing. This feature gives the operator a clear view of the reaction zone, increasing cutting efficiency.

The forward end of the ACL-3 mounts a quick-release chuck-type pipe holder. Unthreaded pipe or tubing can be inserted or removed with a quick, simple turn of the chuck. Each lance is supplied with a handy repair kit that includes everything needed to maintain the ACL-3 under normal operating conditions.

(*Please turn to page 238*)

Yes—stripped of all side issues a backstop must provide:

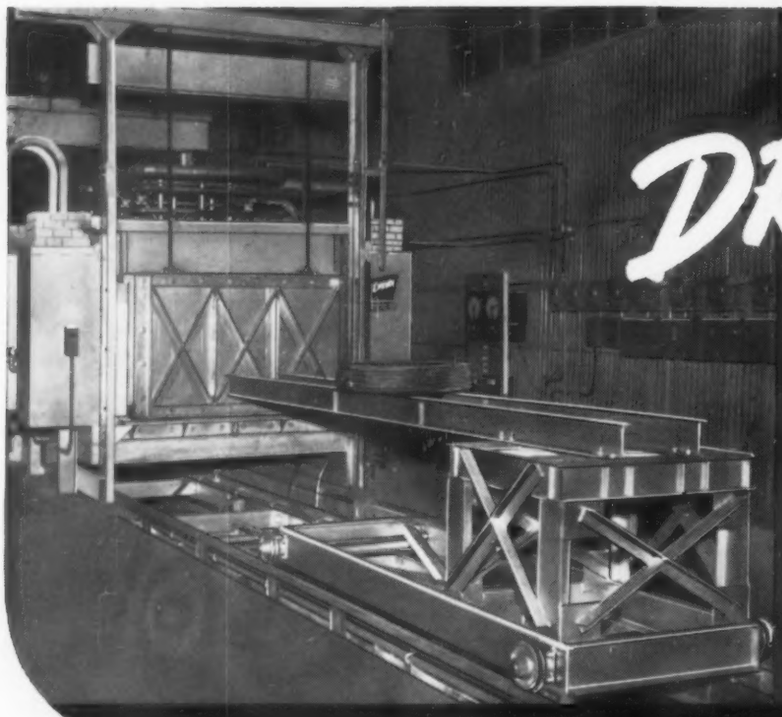
safety for your operating personnel against bodily injuries;

protection for your expensive inclined conveying or elevating equipment from possible damaging reversed runaway;

safeguards for your production schedules.

For safe, dependable operation—day after day, year after year—at lowest operating cost, refer to Marland One-Way Engineering Manual No. 56.

MARLAND ONE-WAY CLUTCH COMPANY
561 HILLGROVE AVENUE, LA GRANGE, ILLINOIS



DREVER

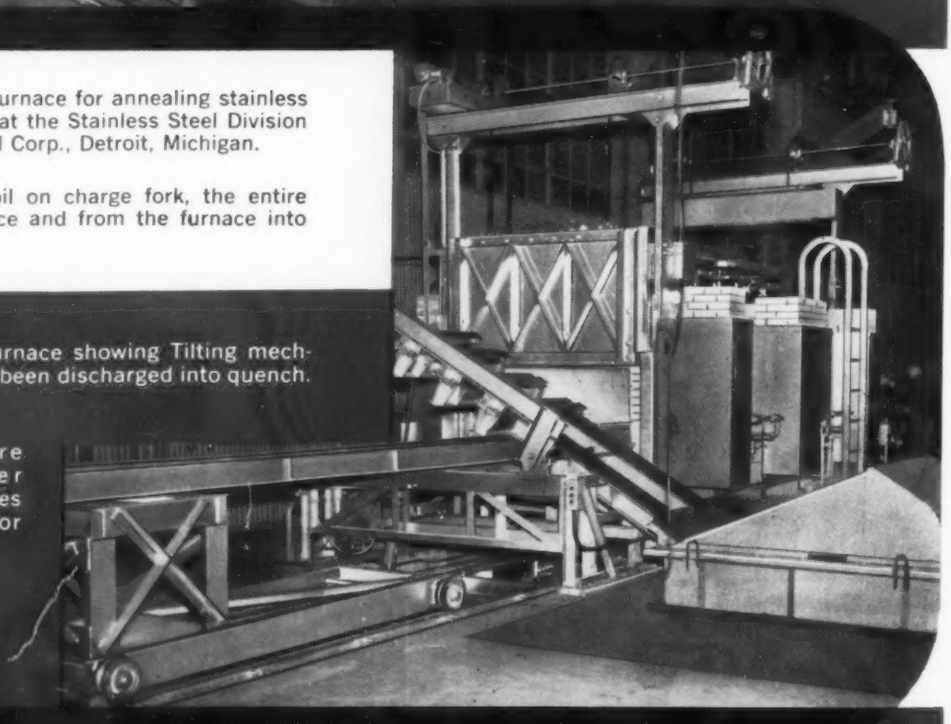
Stainless Wire Coil Annealers

Charge end of a Drever furnace for annealing stainless steel wire coils installed at the Stainless Steel Division of Jones & Laughlin Steel Corp., Detroit, Michigan.

After operator places coil on charge fork, the entire operation into the furnace and from the furnace into the quench is automatic.

Discharge end of furnace showing Tilting mechanism after coil has been discharged into quench.

Two quenches are supplied; water quench for 300 series and oil quench for 400 series.



Drever's gas-fired coil annealing furnace is designed to handle (4) 250 lb. coils of wire per hour. Coils vary from 36" to 48" O.D. in size and from 200 to 250 lbs. in weight.

Uniform and rapid heating of coils is accomplished with a minimum of scale formation.

Consult Drever engineers on your stainless wire, rod, bar, sheet, plate and strip heating problems.

DREVER COMPANY

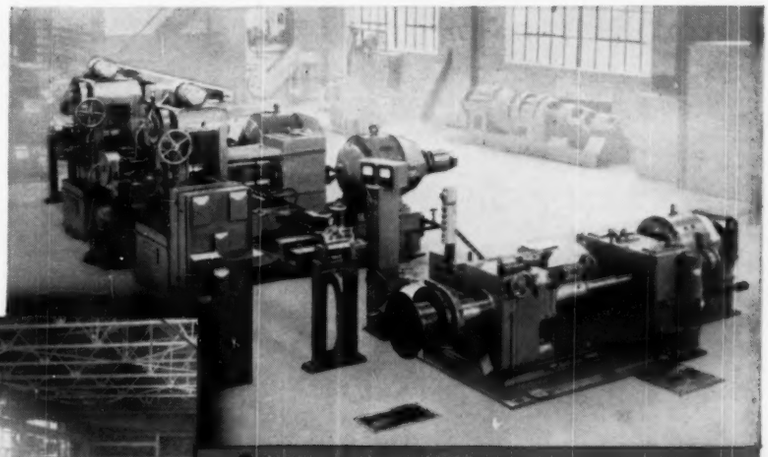
RED LION ROAD and PHILMONT AVE., BETHAYRES, PA.

37

Waterbury Farrel Wire Flattening MILLS IN ACTION

Pictured here are a few of the many Wire Flattening Mills designed and built by Waterbury Farrel. Each installation was custom-engineered to fit the production requirements of each individual customer.

Whether your requirements call for a single or multiple stand mill, Waterbury Farrel can supply you with a reliable production unit that will prove to be a profitable investment.

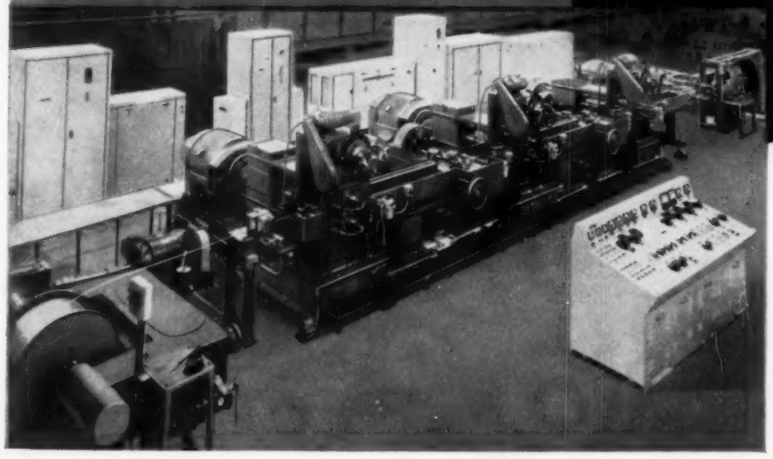


Two Stand Tandem Wire Flattening Mill at National Electric Coil Co., Columbus, Ohio. Speeds up to 1000 feet per minute.

Two Stand Tandem Wire Flattening Mill recently installed at John A. Roebling's Sons Corp., Trenton, N. J. Speeds up to 1500 feet per minute..

Three Stand Tandem Wire Flattening Mill in production for Anaconda American Brass Co. Ltd. (Subsidiary of the American Brass Co.) New Toronto, Ontario, Canada. Speeds up to 1800 feet per minute.

Three Stand Tandem Wire Flattening Mill installed at General Electric Co. in their Pittsfield Works. Speeds up to 2500 feet per minute..

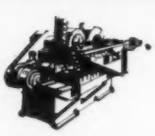


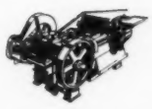
Write today for your free copy of Wire Flattening Mills, Cir. No. 731-R.

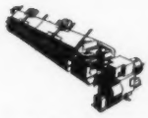
WATERBURY FARREL

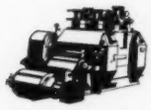
THE WATERBURY FARREL FOUNDRY & MACHINE CO. Waterbury, Conn.

Sales Offices:
Chicago • Cleveland • Millburn, N. J.









WATERBURY FOUNDED 1851 FARREL

Bolt, Nut & Screw Machinery • Power Presses • Rolling Mill Machinery • Wire Mill Equipment • Sendzimir Mills and other Special Machinery

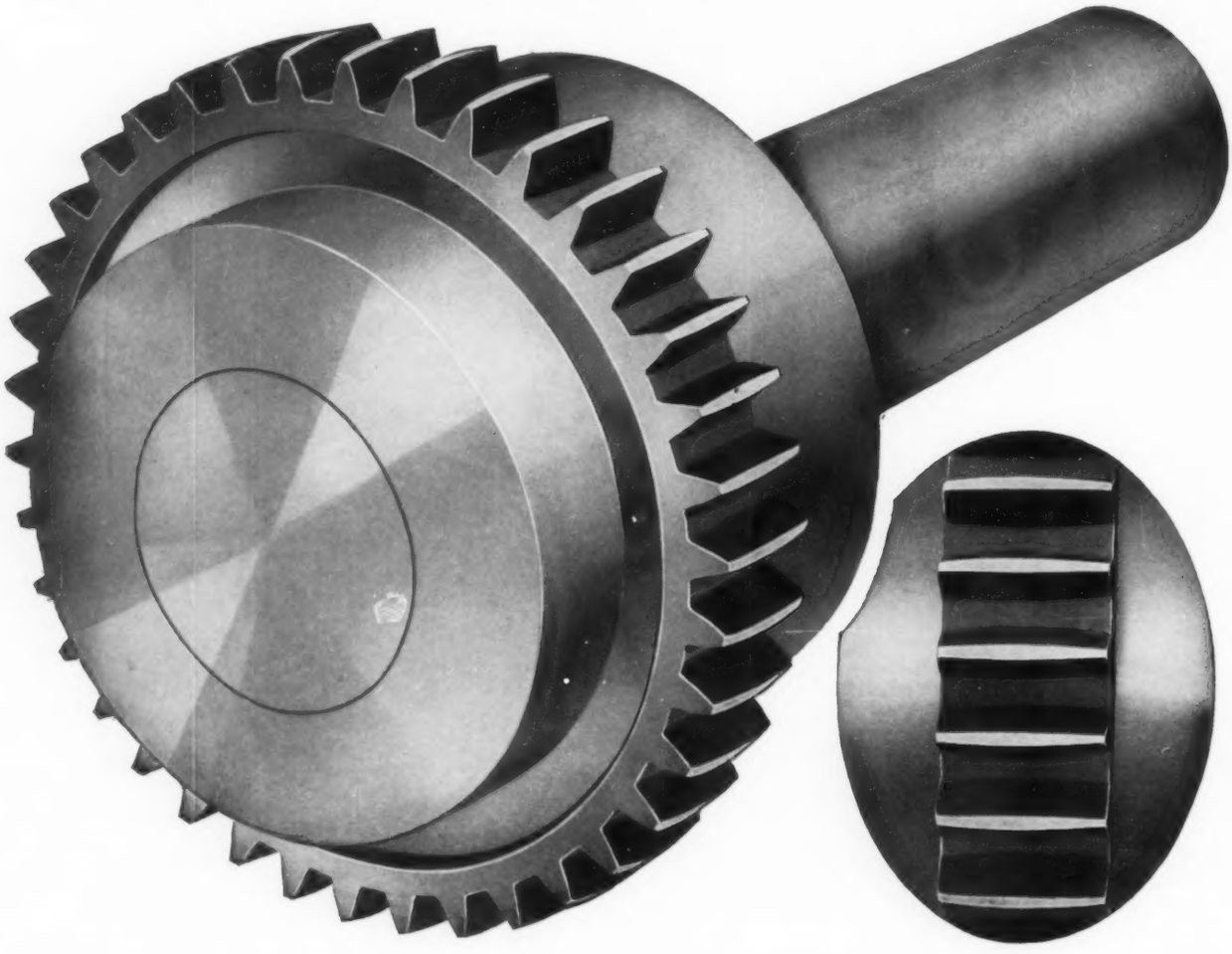
WF-32

POOLE

CURVED TOOTH COUPLINGS FOR GREATER MISALIGNMENT

We are now equipped to furnish on special order, couplings up to and including size No. 12 with curve-sided hub teeth, permitting misalignment up to plus or minus 5°.

This feature solves many problems where excessive misalignment becomes unavoidable, such as coupling arrangements which necessitate changing centers of rolls etc., or any sort of drive requiring more than the standard plus or minus 1°.



The method by which this is done represents the very latest gear cutting process. Gear teeth cut by this amazing and ultra modern method are not only to a precise and absolutely true shape, but are also generated to tolerances of astounding accuracy.

Engineers and draftsmen, when confronted with coupling problems involving more than the usual amount of misalignment, are invited to submit such problems to us for recommendation to suit their exact requirements.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY **1700 UNION AVE.** **BALTIMORE 11, MD.**

THE ENGINEERING MART

WHERE TO BUY
EQUIPMENT FOR SALE
POSITIONS VACANT
POSITIONS WANTED

AN *IRON and STEEL ENGINEER* SERVICE TO THE STEEL MILL OPERATORS

WHERE TO BUY

BIRMINGHAM DISTRICT

DIXIE ENGINEERING COMPANY
"Manufacturer's Agents"
812-813 Protective Life Building
BIRMINGHAM 3, ALABAMA
Sabel E. Baum — Telephone 4-0417

CHICAGO DISTRICT

PAUL W. WENDT & SONS
Manhattan Building
CHICAGO 5, ILLINOIS
District Representatives for
A. W. CADMAN MFG. CO.
HUNTER SAW & MACHINE CO.
GRAFO COLLOIDS CORP.

EHRET AND KINSEY
Board of Trade Bldg., 141 West Jackson Blvd.
Chicago 4, Illinois — Wabash 2-0449
Representing
THE CLEVELAND WORM AND GEAR CO.
"Cleveland" Worm Gearing and Worm Gear Speed Reducers—30 Years
THE FARVAL CORPORATION
"Farval" Centralized Lube Systems—30 Years
LUBRICATION PRODUCTS COMPANY
"Strapax" Journal Box Lubricator—24 Years
AMERIGEAR-ZURN, INC.
"Amerigear" Flexible Couplings—9 Years
WALDES KOHINOOR, INCORPORATED
"Truarc" Retaining Rings—11 Years
AMERIGEAR-BLISS SPINDLE COUPLING DIVISION, E. W. BLISS CO.
Spindle Couplings
3904 West Vliet St. — Phone:
Milwaukee 8, Wisc. — Division 2-7844

The C. W. THOMSON COMPANY
"Wired Communication Specialists"
• Loudspeaking Communication & Paging
• Battery Operated Portable Equipment
1718 Tytus Avenue — Middletown, Ohio

PITTSBURGH DISTRICT

ROLLING MILLS and EQUIPMENT
FRANK B. FOSTER, INC.
2220 OLIVER BUILDING PITTSBURGH 22, PA.
Cable Address "FOSTER" Pittsburgh

PITTSBURGH (Continued)

ELECTRICAL INSTALLATIONS
PATTERSON EMERSON COMSTOCK, INC.
PITTSBURGH, PA.
STEEL MILLS—INDUSTRIALS UTILITIES
313 EAST CARSON ST. — ZONE 19

W. G. KERR CO., INC.
1005 Liberty Ave. — PITTSBURGH, PA.
Phone: ATlantic 1-4254
Representing:
FOOTE BROS.—Gears and Speed Reducers
REEVES—Variable Speed Drives
THOMAS—Flexible Couplings
WICHITA—Air Tube Disc Clutches & Brakes
TELSMITH—Telsmith Crushers
CULLEN-FRIESTEDT—Sheet Lifters—Welding Positioners—Track Cranes

The **CALVERT** *Co.*
***Producers of* Calvert Bus**
- BARE BUS FABRICATION
- CABLE LEADS, Air and liquid cooled
- JUNCTION BOXES, 600 to 23,000 volts
- HIGH AMPERE TERMINALS

ED. 3-0353
19851 Ingersoll Dr., Rocky River 16, O.

AUBURN AND ASSOCIATES, INC.
ENGINEERS
COMPLETE
ENGINEERING . DESIGN . LAYOUT
FOR
STEEL MILLS AND HEAVY INDUSTRY
923 Penn Ave., Pgh. 22, Pa.
Telephone COurt 1-5014

PITTSBURGH (Continued)

RITTER ENGINEERING CO.
Engineers • Distributors • Contractors
1409 SEDGWICK ST. — Phone:
PITTSBURGH 33, PA. — FAIRFAX 1-8538
TRABON—Centralized Lubricating Systems
METERFLO—Circulating Oil Systems
PARKER—Hydraulic & Fluid System Components
"Specialists in Lubrication and Hydraulics"

METALLIC RECUPERATORS
(Air Preheaters)
For application to soaking pits, heating, and other types of metallurgical furnaces.
HAZEN ENGINEERING CO.
184 Sandy Creek Road — (Penn Township)
P. O. Box 10597 — PITTSBURGH 35, Pa.
CHurchill 2-1750

CONSULTING ENGINEERS

W. VANCE MIDDOUGH & ASSOCIATES
Consulting Electric Engineers
Engineering • Design • Layout
Heavy Industrial Power & Light
Frederick Building — Cleveland 15, Ohio
Prospect 1-2060

MARTIN J. CONWAY
Consulting Fuel Engineer
111 South Duke Street — Millersville, Pa.
Tel. 6153
Steel Industry Representative for
CHEMICAL CONSTRUCTION CORPORATION
P-A- VENTURI SCRUBBER
Cleaning Blast Furnace, Converter, Open Hearth and Scarfing Gases. Bulletins Available.

ROSS E. BEYNON
Consultant
ROLLING LAYOUT AND ROLL DESIGN
7658 Coles Avenue — Chicago 49, Illinois
Telephone SAginaw 1-3466

National Design & Detailing Co.
3633 Brownsville Road
Pittsburgh 27, Pa.
TUxedo 4-2200 — Cable: DETAILCO
Structural-Mechanical-Electrical
COMPLETE INDUSTRIAL PLANTS
Sintering Plants • Foundries • Mill Bldgs.
Welding Consultants

THE ENGINEERING MART

Consulting Engineers (Continued)

HOUSER AND CARAFAS ENGINEERING CO.

Engineering for Industry

4 Smithfield Street Pittsburgh 22, Pa.

Phone: GRant 1-9929

ENGINEERING SERVICE BUREAU

Consultants & Design Engineers For The Steel Industry

BEN MACCABEE 173 W. Madison St.
S. L. JAMESON CHICAGO 2, ILLINOIS

PRODUCTS

POSITIONS WANTED

ACCOUNTS WANTED

Established Manufacturer's Agent is desirous of representing additional lines in Western Pennsylvania, West Virginia, and Eastern Ohio. Preferably those products sold direct to steel mills or steel mill equipment builders. Box 301, Iron & Steel Engineer, 1010 Empire Building, Pittsburgh 22, Pa.

POSITION WANTED

Tin Plate Mill Superintendent
AVAILABLE

Box 302, IRON AND STEEL ENGINEER, 1010 Empire Building, Pittsburgh 22, Pa.

USE THE ENGINEERING MART

Equipment News

(Continued from page 233)

CAPACITOR

△ For extremely high microfarad applications such as the "bulk capacitance" requirements of computer power supplies, General Electric Co. offers a completely new line of d-c "Alumalytic" capacitors. These units which have been designed specifically for circuits demanding highest reliability are rated from 30,000 uf at 10 vdc to 1000 uf at 450 vdc and will operate from −20 to +65 C.

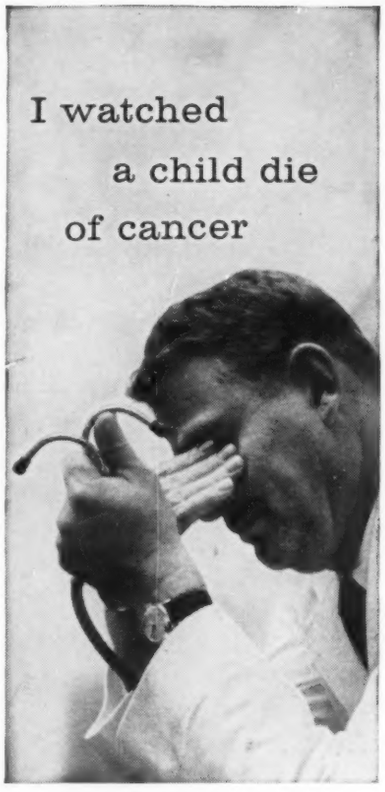
The principal construction feature of this capacitor is the use of 99.99 per cent pure aluminum foil anodes in every rating. This type of pure aluminum permits greatly increased shelf and operating life, reduces leakage current and insures other excellent performance characteristics.

Units are encased in aluminum containers and when specified may be insulated by either cardboard or cellulose acetate tubes.

Book Reviews

"Dislocations and Mechanical Properties of Crystals," edited by J. C. Fisher, W. G. Johnston, R. Thomson, and T. Vreeland, Jr., has been recently published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. The book contains 634 pages, 6 x 9 in., is cloth bound, and sells for $15.00. The book is based on the International Conference held at Lake Placid, September 6–8, 1956, sponsored by the Air Force Office of Scientific Research, Air Research and Development Command, and the General Electric Research Laboratory, with contributions by fifty-four of the world's leading authorities in the field contributing to make it a complete and up to date account.

"1957 Supplements to Book of ASTM Standards," 7 parts, has just been issued. These seven parts are: Part 1. Ferrous Metals—520 pages, includes 80 standards; Part 2. Non-Ferrous Metals—380 pages, includes 56 standards; Part 3. Cement, Concrete, Ceramics, Thermal Insulation, Road Materials, Waterproofing, Soils—360 pages, includes 60 standards; Part 4. Paint, Naval Stores, Wood, Cellulose, Wax Polishes, Sandwich and Building Constructions, Fire Tests—218 pages, includes 33 standards; Part 5. Fuels, Petroleum, Aromatic Hydrocarbons, Engine Antifreezes—340 pages, includes 76 standards; Part 6. Rubber, Plastics, Electrical Insulation—423 pages, includes 70 standards; and Part 7. Textiles, Soap, Water, Paper, Adhesives, Shipping Containers—280 pages, includes 40 standards. The 1957 supplements, in heavy paper covers, can be obtained from the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., at $4.00 per part or $28.00 for the complete set of seven parts.



SHE WAS too weak to speak . . . this child of eight. But the words were plain to see in her eyes: *"Can't you make me well again, Doctor?"*

It's terribly hard . . . even for a doctor who sees tragedy enough . . . to watch a child fade from the sunlight of life—a victim of cancer.

We *had* succeeded in prolonging her life by many months—thanks to recent advances in the treatment of leukemia.

But that's not enough! Cancer is a disease that ranks today as the Number 1 disease-killer of children. We can . . . we must . . . find ways to battle it, and *win over it*.

Research, supported by the American Cancer Society, is striving towards that goal.

Let's give . . . boldly, generously to the American Cancer Society Crusade . . . and help eliminate this mortal enemy which will take the lives of more than 250,000 Americans this year alone.

Send your gift to CANCER in care of your local post office.

AMERICAN CANCER SOCIETY

INDEX TO ADVERTISERS

MARCH, 1958

A

Adams Co., Inc., R. P. 194
Aetna-Standard Engineering Co. 1
Air Products, Inc. 58
Ajax Flexible Coupling Co. 57
Allen-Bradley Co. 180
Alliance Machine Co. 222
Aluminum Co. of America 45
American Brakeblok Div., American Brake Shoe Co. 201
American Chain & Cable Co., Inc., Campbell Machine Div. 229
American Messer Corp. 23
Ampco Metal, Inc. 68
Appleton Electric Co. 158
Askania Regulator Co. 170
Atlantic Refining Co., The 28
Atlas Car & Mfg. Co. 166

B

Babcock & Wilcox Co., The 156
Bailey Co., William M. 224
Bailey Meter Co. 38
Baldwin-Lima-Hamilton Corp., Eddystone Div. 187
Bearings, Inc. 188
Berry Bearing Co. 19
Bethlehem Steel Co. 8
Birdsboro Steel Foundry & Machine Co. 64
Blaw-Knox Co., Foundry and Mill Machinery Div. 169
Bliss Co., E. W. 59
Bloom Engineering Co., Inc. 228
Browning and Co., Inc., Victor R. 6

C

Campbell Machine Div., American Chain & Cable Co., Inc. 229
Chandeysson Electric Co. 51
Chemical Construction Corp. 193
Clark Controller Co. 5
Cleveland Crane and Engineering Co. 10
Cone-Drive Gears Div., Michigan Tool Co. 39
Cutler-Hammer Inc. Cover 2, 214

D

DeLaval Steam Turbine Co. 69
Documentation and Licenses, Paris, France 2
Dowell, Inc. 18
Dravo Corp. 29
Drever Co. 234

E

Eddystone Div., Baldwin-Lima-Hamilton Corp. 187
Eichleay Corp. 161
Electric Controller and Manufacturing Co., Square D Co. 195
Electric Furnace Co., The 49
Electro-Alloys Div., American Brake Shoe Co. 20
English Electric Co. of Canada Limited 168
Euclid Electric & Mfg. Co., The 193
Exide Industrial Div., Electric Storage Battery Co. 65

F

Farval Corp., The Cover 3
Feller Engineering Co. 220, 221
Flinn and Dreffein Engineering Co. 2
Foxboro Co., The 219
Frantz Co., Inc., S. G. 194

G

Garlock Packing Co., The 185
Gear Grinding Machine Co. 225
General Electric Co. 66, 67
Great Lakes Carbon Corp. 172

H

Hagan Chemicals & Controls Inc. 165
Hallden Machine Co., The 2
Harbison-Walker Refractories Co. 26
Heyl and Patterson, Inc. 33
Hunt and Son, Inc., C. B. 200
Hyatt Bearings Div., General Motors Corp. 7

I

Industrial Crane & Hoist., Borg-Warner Corp. 16
Ingersoll-Rand Co. 173
Iron and Steel Exposition 218
I-T-E Circuit Breaker Co., Switchgear Div. 63

K

Koppers Co., Inc. 42, 205, 206, 207, 208, 213

L

Larco, Inc. 194
Lectromelt Furnace Div., McGraw-Edison Co. 70
Leeds and Northrup Co. 62
Link-Belt Co. 12, 13, 60

M

Mackintosh-Hemphill Div., E. W. Bliss Co. 177
Manning, Maxwell and Moore, Inc. 61
Marland One-Way Clutch Co. 233
McKiernan-Terry Corp. 167
Mesta Machine Co. 210
Miles and Partner, John, London, Ltd. 2
Minneapolis-Honeywell 52, 53
Morgan Construction Co. 55
Morgan Engineering Co., The 4

N

National Carbon Co., Union Carbide Corp. 199
National Electric Coil Co. 240

O

Ohio Steel Foundry Co., The 196
Okonite Co., The 183

P

Pangborn Corp. 179
Pennsylvania Transformer Div., McGraw-Edison Co. 30, 31
Pollock Co., William B. 43
Poole Foundry and Machine Co. 236
Post-Glover Electric Co. 54

R

Ramtite Co., The 226
Refractories Div., Laclede Christy Works, H. K. Porter Co., Inc. 230
Reliance Electric & Engineering Co. 175
Republic Flow Meters Co. 44
Rockwell Co., W. S. 160
Rollway Bearing Co. 217
Rust Furnace Co. 155
Rust-Oleum Corp. 36, 37

S

Selas Corp. of America 40, 41
Sel-Rex Corp. 231
Spraying Systems Co. 35
Square D Co., Electric Controller & Mfg. Co. 9
Stamco, Inc. 216
Surface Combustion Corp. 14, 15
Syntron Co. 32

T

Taylor Chain Co., Inc., S. G. 227
Taylor Instrument Cos. 56
Texas Co., The Cover 4
Timken Roller Bearing Co., The Cover 1
Torrington Co., The 48

U

Union Carbide Corp., National Carbon Co. 199
United Engineering and Foundry Co. 17
United Engineers & Constructors Inc. 47
United States Graphite Co. 34

V

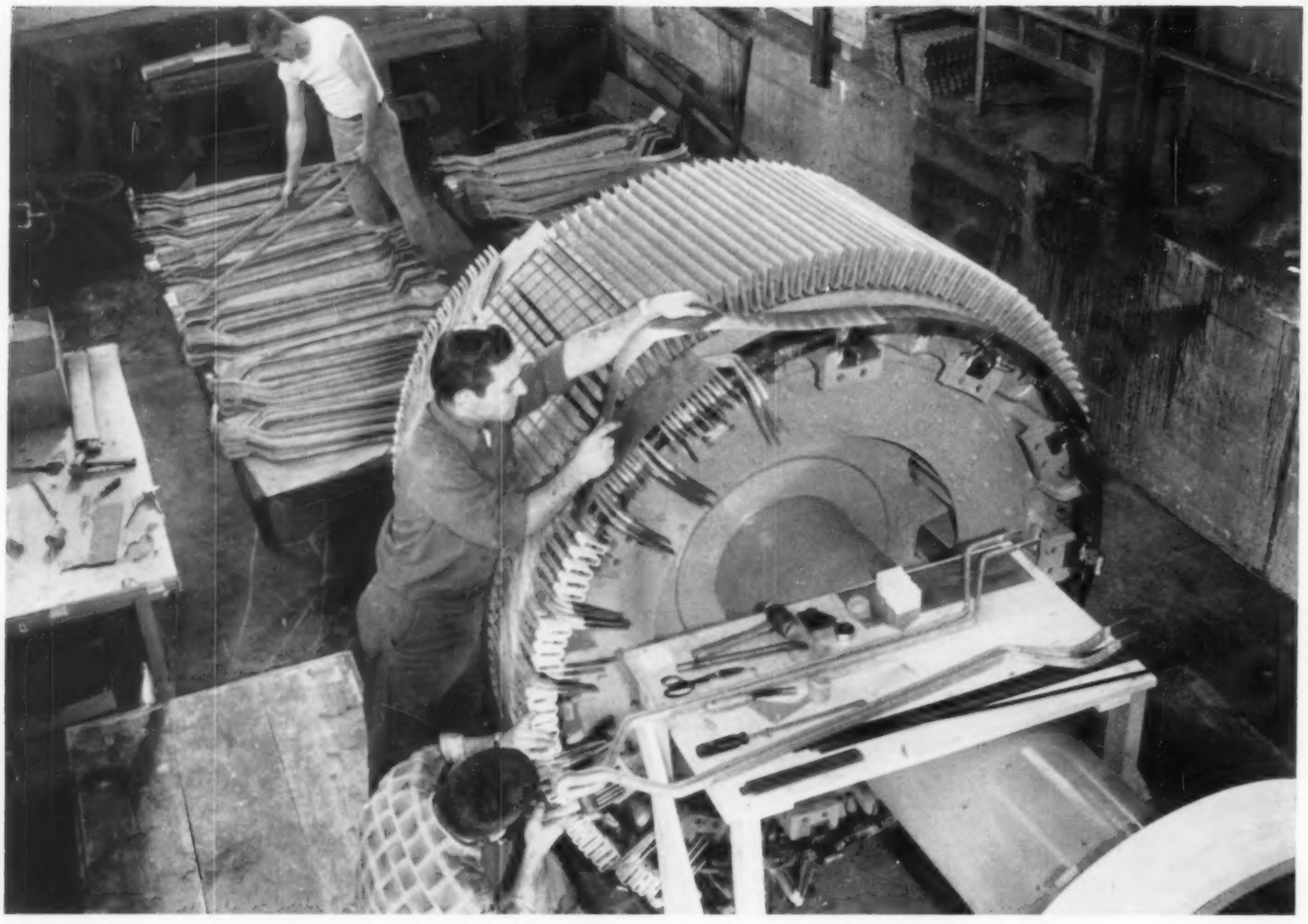
Vaughn Machinery Co., The 202

W

Waldron Corp., John 198
Waterbury Farrel Foundry and Machine Co. 235
Wean Engineering Co., Inc., The 2
Wean Engineering Co. of Canada, Ltd., Tne 2
Wean Equipment Corp. 2
Western Precipitation Corp. 46
Wichita Clutch Co. 25
Wilson Engineering Co., Inc., Lee 162, 163

Y

Yoder Co., The 50
Youngstown Alloy Casting Corp. 192



here's how NATIONAL saved a steel mill time and money by changing the operating characteristics of a motor

A midwestern steel mill needed a 60-cycle motor to drive two generators which furnished D.C. power for a rolling mill. They had available a 25 cycle, 2300 V. motor rated at 5,000 HP, 375 RPM. When asked to convert this to the mill frequency, National redesigned and rebuilt it to 60 cycle, 4,000 HP, 12,000 V., 360 RPM—adequate for all requirements. Winding of the rotor is shown in photo above.

Where redesign can produce the change you need, it offers substantial savings over the cost of new equipment—particularly when you can take advantage of idle equipment you already own.

When time is a factor, redesign and rewinding can be completed in a much shorter time than it normally takes to get delivery on a new machine.

For detailed information on similar problems of your own, give your nearby National field engineer a call or get in touch with us here in Columbus.

NATIONAL ELECTRIC COIL COMPANY

COLUMBUS 16, OHIO, U. S. A.

TRADE MARK

ELECTRICAL ENGINEERS: MAKERS OF ELECTRICAL COILS AND INSULATION—REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

Farval serves 1133 mill and crane bearings in Atlantic Steel's new bar and rod mill

FARVAL—
Studies in Centralized Lubrication
No. 205

KEYS TO ADEQUATE LUBRICATION—

Inset above shows Farval automatic pumping station No. 3, serving 240 points on 15 horizontal mills, edging mill, furnace switch and pullout, all designed and manufactured by Morgan Construction Company. Above you see *Farvalized* overhead crane and runout tables in the Atlantic Steel Co. mill room.

●Last word for modern machines and manufacturing practice, this Atlanta steel company also employs the most modern method of lubrication—Farval Centralized Lubrication. Twenty-four Farval systems keep mills and cranes running smoothly, serving a total of 1133 bearings.

You'll generally find Farval in evidence wherever steel is made or worked. Literally thousands of systems, automatic and manually operated, protect millions of bearings in the metals industries—some of them still efficiently on the job after 25 to 30 years of service.

Farval is the original Dualine system of centralized lubrication that delivers measured amounts of oil or grease under pressure to every bearing as often as desired. No bearing is ever missed.

Write for newly revised Bulletin 26-S, which tells the whole Farval story. The Farval Corporation, 3278 E. 80th St., Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing.
In Canada: Peacock Brothers Limited.

Working gear-drives harder than ever?
EP properties in Meropa give tough protection

Today's heavier loads and higher speeds on gear-drives demand a lubricating film of greater toughness. And extra toughness—far beyond load-capacity requirements—is what you get from Texaco Meropa Lubricant. Its special Extreme-Pressure properties cushion metal surfaces against wear . . . allow gears to run smoothly. Too, polar additives in Meropa insure greater protective adhesion to metals under all conditions—even under shock loads and severe heat, pressure and moisture.

What's more, Texaco Meropa resists oxidation, foaming, thickening. It is stable in use, storage and centrifuging. It does not corrode gear and bearing metals. The result: long equipment life—and low maintenance costs.

There are 10 viscosity grades of Meropa lubricants, to help you get maximum performance from your heavy-duty equipment. A Texaco Lubrication Engineer will gladly help you select the best grade for your needs. Just call the nearest of the more than 2,000 Texaco Distributing plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TUNE IN . . . Metropolitan Opera Radio Broadcasts Every Saturday Afternoon

LUBRICATION IS A MAJOR FACTOR IN COST CONTROL

(PARTS, INVENTORY, PRODUCTION, DOWNTIME, MAINTENANCE)